High frequency microphone measurements for transition detection on airfoils. NACA-0015 appendix report

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High Frequency Microphone Measurements for Transition Detection on Airfoils NACA-0015 Appendix Report

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Risø–R–1645(App.3)(EN)

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May 2008

DTU

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Title: High Frequency Microphone Measurements for Transition Detection on Airfoils - Risø NACA-0015 Appendix Report

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Abstract:
This report is an appendix to [1]. A comprehensive set of results are presented which allows the transition on airfoils to be detected. Results for the NACA-0015 profile are presented.

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Contents

List of symbols

σ	Sample standard deviation [Pa]
α	Angle of attack [deg]
x	Chordwise position [m]
Re	$\frac{cU}{\nu}$ Reynolds number [-]
P_s	Power spectrum of $\mathbf{Y}$ [Pa]
f_1, f_2	High and lower bound of filtered σ [Hz]
μ_n	Statistical moments of P_s of order n [Hz]
x	Chordwise coordinate (positive from leading edge to trailing edge) [m]
x_{tr}	Transition point [m]
c	Chord length [m]
$0.5\rho U^2$	Dynamic pressure [Pa]
U	Incoming velocity (in windtunnel) [m/s]
ν	Kinematic viscosity [m^2/s]

1 Introduction

For a full introduction refer to [1].

Important information !

In figures where XFoil data is presented the filenames are also given and the corresponding simulation parameters can be found in section 3. In XFoil the transition point is calculated at the same Reynolds and Mach number as the experiment it is compared to, but in most cases a free transition is specified (corresponding to a clean profile) even though roughness etc. is used in the experiment.

If the following is specified, it means that the standard deviation of pressure fluctuations σ is calculated as the sample standard deviation

$$f_1 = 0\,\text{Hz}, f_2 = 25000\,\text{Hz}$$

If the following is specified, σ is calculated using Fourier data and the values are lower than the physical data. Refer to [1] for details.

$$f_1 = 2000\,\text{Hz}, f_2 = 25000\,\text{Hz}$$

2 Table of data

Re	Tag	Description	Grid[mm]	Log-file*
1.60e6	C16	Clean	-	
3.0e6	C3	Clean	-	
4.0e6	C4	Clean	-	
5.0e6	C5	Clean	-	
6.0e6	C6	Clean	-	
1.60e6	Z16	ZZ90 x/c=5% suc. x/c=10% press.	-	
3.0e6	Z3	ZZ90 x/c=5% suc. x/c=10% press.	-	
6.0e6	Z6	ZZ90 x/c=5% suc. x/c=10% press.	-	
1.60e6	T16	Trip wire. Bump tape 2%	-	
3.0e6	T3	Trip wire. Bump tape 2%	-	
6.0e6	T6	Trip wire. Bump tape 2%	-	
1.60e6	C16a	Clean	200x200	
3.0e6	C3a	Clean	200x200	
6.0e6	C6a	Clean	200x200	
1.60e6	Z16a	ZZ90 x/c=5% suc. x/c=10% press.	200x200	
3.0e6	Z3a	ZZ90 x/c=5% suc. x/c=10% press.	200x200	
6.0e6	Z6a	ZZ90 x/c=5% suc. x/c=10% press.	200x200	
1.60e6	T16a	Trip wire. Bump tape 2%	200x200	
3.0e6	T3a	Trip wire. Bump tape 2%	200x200	
6.0e6	T6a	Trip wire. Bump tape 2%	200x200	
1.60e6	C16b	Clean	100x100	
3.0e6	C3b	Clean	100x100	
6.0e6	C6b	Clean	100x100	
1.60e6	Z16b	ZZ90 x/c=5% suc. x/c=10% press.	100x100	
3.0e6	Z3b	ZZ90 x/c=5% suc. x/c=10% press.	100x100	
6.0e6	Z6b	ZZ90 x/c=5% suc. x/c=10% press.	100x100	
1.60e6	T16b	Trip wire. Bump tape 2%	100x100	
3.0e6	T3b	Trip wire. Bump tape 2%	100x100	
6.0e6	T6b	Trip wire. Bump tape 2%	100x100	

*All the data is in the same log file: ”Profile log.pdf”

3 Table of XFoil data

Re	*M*	file	N_{crit}	Forced x_{tr}
1.60e6	0.08	N0015Re16M08Ncr9.pol	9	-
		N0015Re16M08Ncr8.pol	8	-
		N0015Re16M08Ncr6.pol	6	-
		N0015Re16M08Ncr4.pol	4	-
		N0015R16N8Tr0510.pol	8	x_{tr}/c=5% suc. 10% press.
		N0015R16N6Tr0510.pol	6	x_{tr}/c=5% suc. 10% press.
3.00e6	0.15	N0015Re30M15Ncr9.pol	9	-
		N0015Re30M15Ncr8.pol	8	-
		N0015Re30M15Ncr6.pol	6	-
		N0015Re30M15Ncr4.pol	4	-
		N0015R30N8Tr0510.pol	8	x_{tr}/c=5% suc. 10% press.
		N0015R30N6Tr0510.pol	6	x_{tr}/c=5% suc. 10% press.
4.00e6	0.20	N0015Re40M20Ncr9.pol	9	-
		N0015Re40M20Ncr8.pol	8	-
		N0015Re40M20Ncr6.pol	6	-
		N0015Re40M20Ncr4.pol	4	-
5.00e6	0.25	N0015Re50M25Ncr9.pol	9	-
		N0015Re50M25Ncr8.pol	8	-
		N0015Re50M25Ncr6.pol	6	-
		N0015Re50M25Ncr4.pol	4	-
6.00e6	0.30	N0015Re60M30Ncr9.pol	9	-
		N0015Re60M30Ncr8.pol	8	-
		N0015Re60M30Ncr6.pol	6	-
		N0015Re60M30Ncr4.pol	4	-
		N0015R60N8Tr0510.pol	8	x_{tr}/c=5% suc. 10% press.
		N0015R60N6Tr0510.pol	6	x_{tr}/c=5% suc. 10% press.

Table 1: XFoil datafiles

If not otherwise stated the following boundary layer parameters have been used.

`Vacc`	0.0100
`Klag`	5.6000
`Uxwt`	1.00
`A`	6.7000
`B`	0.7500
`KCt`	0.01485
`CtiniK`	1.8000
`CtiniX`	3.3000

Table 2: XFoil parameters

4 Suction side

4.1 C16 Clean -

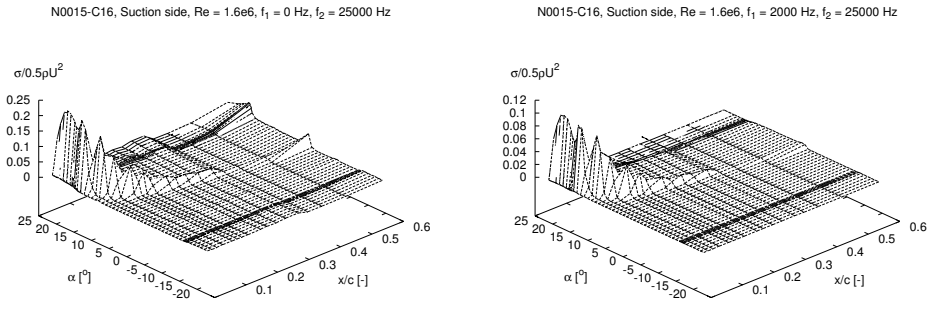

Figure 1: Pressure standard deviations, σ

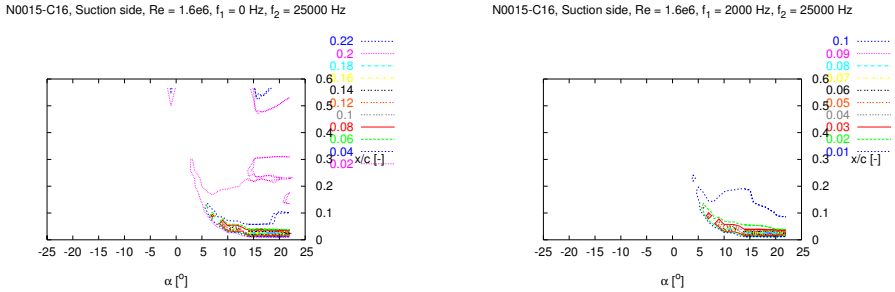

Figure 2: Contours of σ

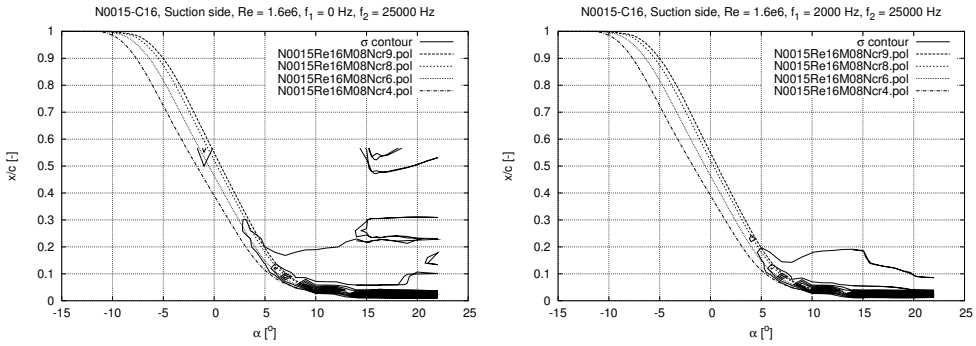

Figure 3: Contours of σ and XFoil data

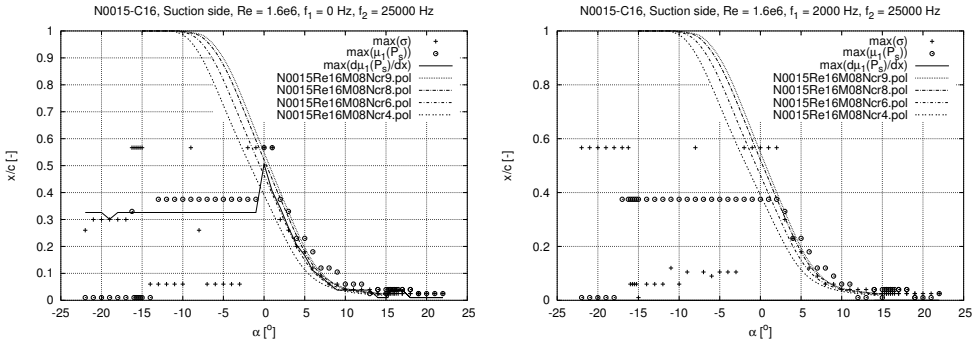

Figure 4: Transition detection

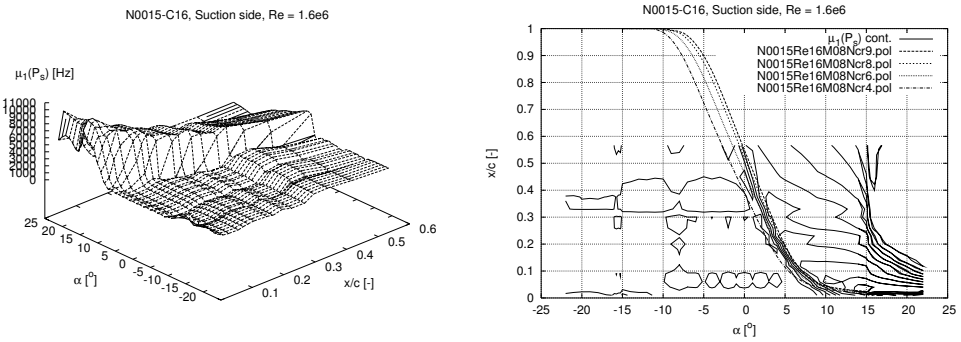

Figure 5: Fourier transform mean, $\mu_1(P_s)$

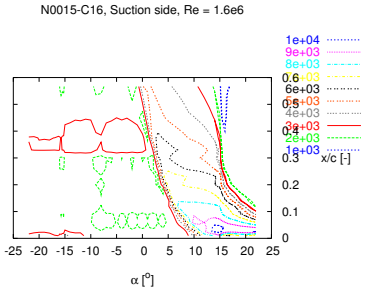

Figure 6: Contours of $\mu_1(P_s)$

```
N0015-C16
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 14.00  0.0100     23669.5   10366.3
 15.00  0.0100      8854.5   10394.3
 15.25  0.0100     25635.9   10177.7
 15.50  0.0380     27099.8   10089.6
 15.75  0.0380     35369.2    9990.0
 16.00  0.0380     35430.7    9954.1
 16.26  0.0380     44045.3    9837.2
 17.00  0.0380     38582.6    9747.0
 18.00  0.0100     27586.3    9540.4
 19.00  0.0100     17439.2    9427.9
 20.00  0.0100      9752.3    9704.9
 21.00  0.0100     10776.7    9694.2
 22.00  0.0100      6753.5   10069.4
 19.00  0.0100     14929.5    9582.4
 18.00  0.0100     26932.2    9588.4
 17.00  0.0380     37270.3    9726.5
 16.50  0.0380     43482.3    9851.8
 16.00  0.0380     36655.1    9979.9
 15.50  0.0380     26526.3   10097.8
```

15.00	0.0100	14631.4	10314.9
14.00	0.0100	21409.3	10377.5
13.00	0.0380	25705.9	9877.1
12.00	0.0380	24051.6	8986.5
11.00	0.0380	60339.1	9158.3
10.00	0.0380	84977.3	9630.3
9.00	0.0380	80181.2	8578.0
8.00	0.0604	85782.0	8579.8
7.00	0.0883	83095.1	8420.0
6.00	0.1107	78407.6	7589.9
5.00	0.1666	86329.0	7709.1
4.00	0.2058	84854.9	6865.1
3.00	0.2702	59912.0	6706.7
2.00	0.3429	56859.1	5600.5
1.00	0.4044	33027.6	5159.8
0.00	0.5051	32366.7	4966.8
-1.00	0.3261	25887.4	3692.9
-2.00	0.3261	26991.3	3640.1
-3.00	0.3261	26004.1	3714.0
-4.00	0.3261	27319.9	3706.3
-5.00	0.3261	26437.0	3769.3
-6.00	0.3261	26977.1	3666.4
-7.00	0.3261	24900.0	3539.7
-8.00	0.3261	22472.8	3082.6
-9.00	0.3261	21568.0	3184.3
-10.00	0.3261	26021.4	3688.5
-11.00	0.3261	25293.2	3709.2
-12.00	0.3261	25005.3	3648.0
-13.00	0.3261	24697.5	3670.1
-14.00	0.3261	24246.3	3737.4
-15.00	0.3261	22808.5	4423.3
-15.25	0.3261	19947.0	3425.0
-15.50	0.3261	19101.5	3368.5
-15.75	0.3261	18589.6	3181.9
-16.00	0.3261	18189.6	3261.0
-16.25	0.3261	13706.1	3047.3
-17.00	0.3261	13331.6	3047.4
-18.00	0.3261	13046.2	3360.3
-19.00	0.3009	13400.5	3622.4
-20.00	0.3261	13330.4	3549.0
-21.00	0.3261	13620.9	3416.9
-22.00	0.3261	13694.2	3230.1

4.2 C3 Clean -

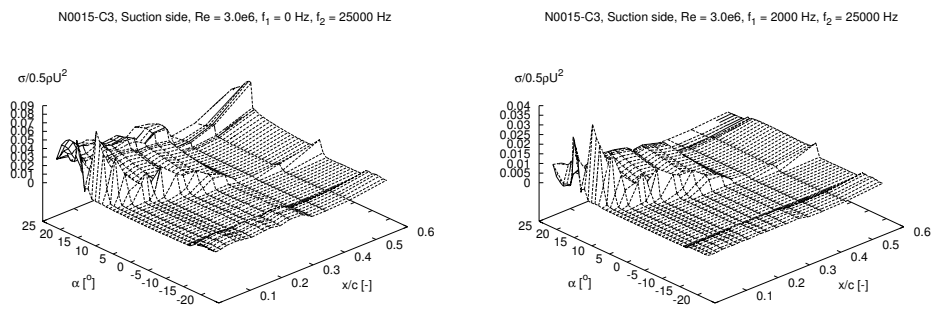

Figure 7: Pressure standard deviations, σ

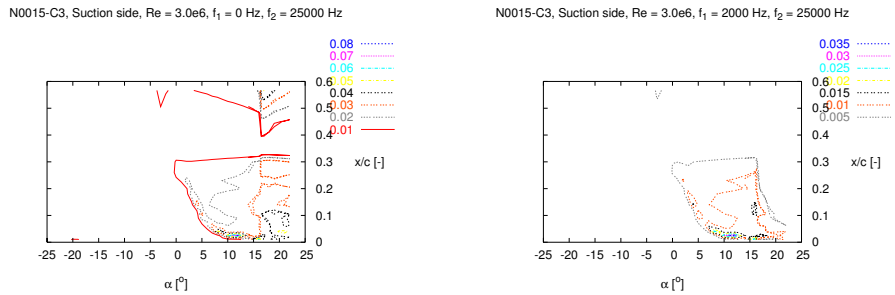

Figure 8: Contours of σ

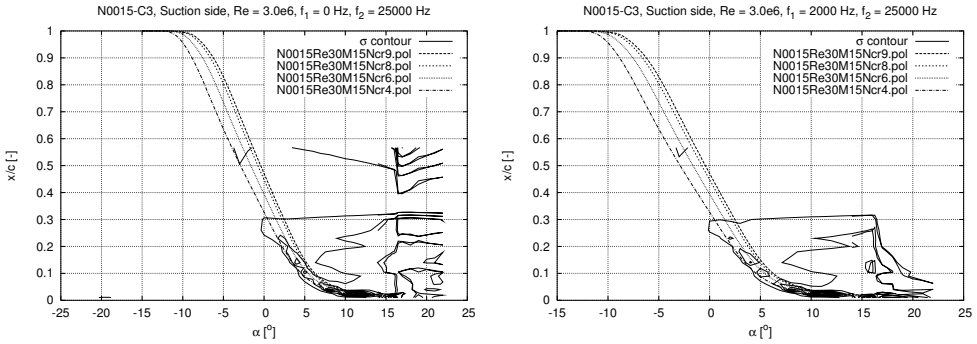

Figure 9: Contours of σ and XFoil data

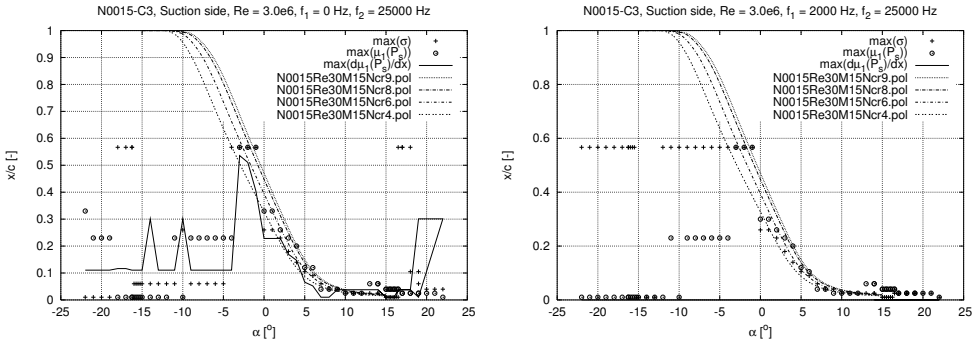

Figure 10: Transition detection

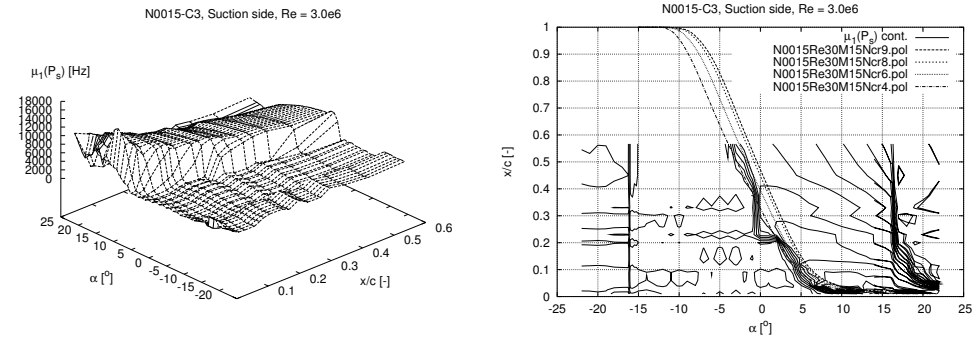

Figure 11: Fourier transform mean, $\mu_1(P_s)$

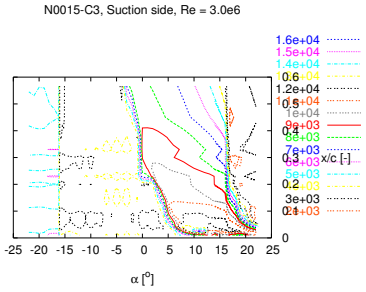

Figure 12: Contours of $\mu_1(P_s)$

```
N0015-C3
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
14.00	0.0380	83529.9	12209.1
15.00	0.0100	42841.3	12680.0
15.25	0.0100	34490.3	12974.6
15.50	0.0100	47515.2	12716.5
15.75	0.0100	45178.0	12765.2
16.00	0.0100	40659.8	12942.1
16.25	0.0100	43465.5	12721.1
16.50	0.0380	30939.5	12257.0
17.00	0.0380	43536.0	12499.6
18.00	0.0380	42433.3	12266.2
19.00	0.3009	17206.7	12118.0
20.00	0.3009	17904.1	11551.6
21.00	0.3009	19311.3	11102.9
22.00	0.3009	20834.9	11403.7
19.00	0.0100	19480.3	11890.6
18.00	0.0380	36907.3	12052.2
17.00	0.0380	42703.5	12198.5
16.50	0.0380	33012.5	12062.2
16.00	0.0100	46506.5	12673.2
15.50	0.0100	46866.6	12594.3
15.00	0.0100	47616.7	12499.3
14.00	0.0380	67466.0	12281.7
13.00	0.0380	42110.7	12080.1
12.00	0.0380	72068.9	15554.0
11.00	0.0380	78465.2	16278.0
10.00	0.0380	83254.8	15562.6
9.00	0.0380	105232.4	13328.9
8.00	0.0100	122445.9	13351.0
7.00	0.0100	156814.5	12566.8
6.00	0.0520	121452.5	11781.6
5.00	0.0659	91753.8	11086.3
4.00	0.1471	91426.0	10848.7
3.00	0.1694	98896.1	10862.6
2.00	0.2282	118841.0	10264.9
1.00	0.2282	104378.0	9645.0
0.00	0.2282	94026.9	9503.6
-1.00	0.4044	65951.2	8852.7
-2.00	0.5107	40081.6	8918.0
-3.00	0.5359	33742.4	7092.5
-4.00	0.1107	15844.3	4138.0
-5.00	0.1107	17267.7	4448.9
-6.00	0.1107	15383.6	4069.6
-7.00	0.1107	16723.3	4357.8
-8.00	0.1107	14956.1	3988.9
-9.00	0.1107	15967.0	4135.5
-10.00	0.3009	13806.3	3975.9
-11.00	0.1107	15537.3	4119.4
-12.00	0.1107	13322.1	3915.7
-13.00	0.1107	13385.5	4451.9
-14.00	0.3009	10648.0	5012.2
-15.00	0.1107	13378.6	4737.4
-15.25	0.1107	10882.0	4523.4
-15.50	0.1107	12620.4	4300.6
-15.75	0.1107	11407.5	4181.6
-16.00	0.1107	12107.5	4236.9
-16.25	0.1107	20965.4	6383.8
-16.25	0.1107	20988.6	6509.0
-17.00	0.1163	21706.6	6498.7
-18.00	0.1163	21900.6	6515.2
-19.00	0.1107	23877.6	5917.5
-20.00	0.1107	24309.3	5877.1
-21.00	0.1107	24623.3	5945.3
-22.00	0.1107	24077.5	5949.1

4.3 C4 Clean -

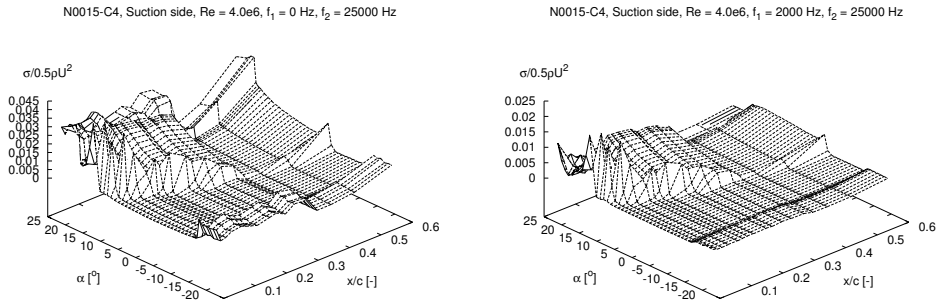

Figure 13: Pressure standard deviations, σ

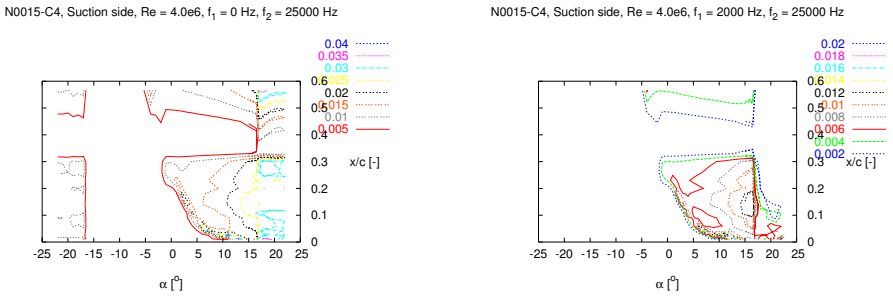

Figure 14: Contours of σ

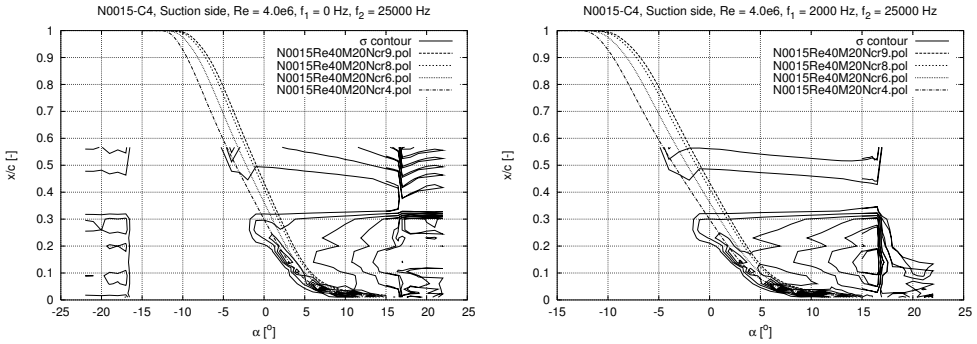

Figure 15: Contours of σ and XFoil data

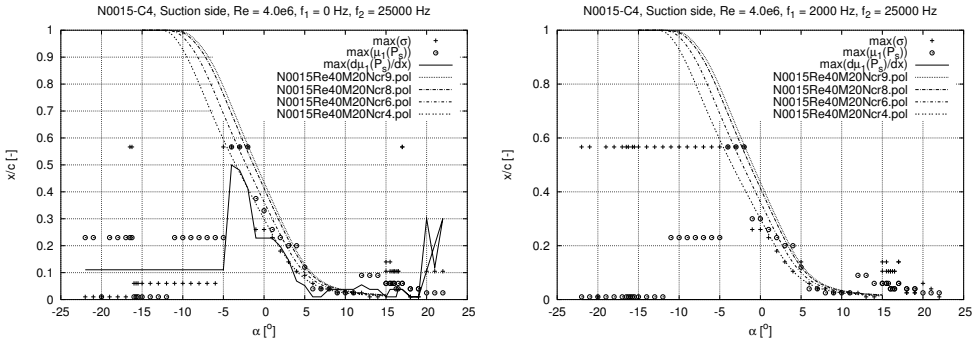

Figure 16: Transition detection

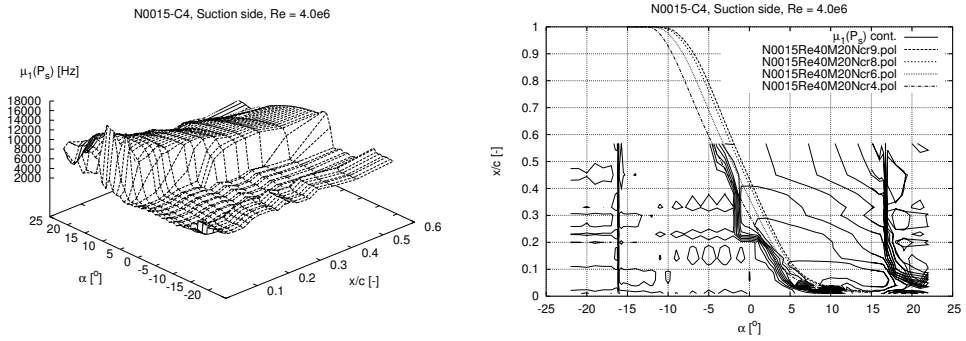

Figure 17: Fourier transform mean, $\mu_1(P_s)$

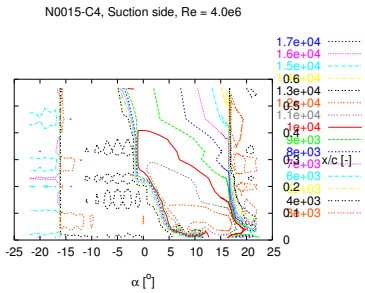

Figure 18: Contours of $\mu_1(P_s)$

```
N0015-C4
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 15.00  0.0100     28635.2   12427.2
 15.50  0.0100     29844.2   12417.0
 15.75  0.0100     30151.6   12409.9
 16.00  0.0100     30481.2   12410.7
 16.25  0.0100     36211.5   12438.2
 16.50  0.0380     37203.4   12444.1
 17.00  0.0380     49194.5   12197.3
 18.00  0.0100     36091.8   11051.8
 19.00  0.0100     44223.6   10686.6
 20.00  0.3009     14444.7    9834.0
 21.00  0.1191     18800.4    9935.9
 22.00  0.3009     12972.8    9823.3
 19.00  0.0100     39344.1   10557.0
 18.00  0.0100     39170.1   10934.4
 17.00  0.0380     50221.2   12315.8
 16.50  0.0380     39852.0   12388.0
 16.00  0.0380     39102.4   12417.3
 15.50  0.0380     36856.9   12414.6
 15.00  0.0100     29405.7   12452.1
 14.00  0.0380     28945.0   12473.6
 13.00  0.0380     39740.4   12624.0
 12.00  0.0548     51452.2   12704.4
 11.00  0.0380    114831.1   17132.2
 10.00  0.0380    126049.2   16626.5
  9.00  0.0380     90168.5   16361.1
  8.00  0.0380    130239.9   12802.1
  7.00  0.0100    235194.0   16307.4
  6.00  0.0100    203515.6   13800.9
  5.00  0.0520    124943.7   12418.6
  4.00  0.0687     92997.3   11794.9
  3.00  0.1471     90663.5   11902.5
  2.00  0.1974     95169.0   11891.3
  1.00  0.2282    120072.2   11455.8
  0.00  0.2282    116645.1   10552.4
 -1.00  0.2282    105497.8   10502.1
 -2.00  0.4128     62958.4   10059.5
 -3.00  0.4799     55771.7   10050.4
 -4.00  0.4995     35194.2    7418.0
 -5.00  0.1107     15361.0    4531.5
 -6.00  0.1107     13694.9    4124.9
 -7.00  0.1107     15262.2    4474.4
 -8.00  0.1107     13482.6    4030.3
 -9.00  0.1107     14973.6    4312.6
-10.00  0.1107     12924.3    3859.3
-11.00  0.1107     14895.9    4242.2
-12.00  0.1107     12564.2    4115.4
-13.00  0.1107     13405.0    4756.1
-14.00  0.1107     11639.4    4449.6
-15.00  0.1107     11991.8    4670.0
-15.50  0.1107     11722.4    4854.7
-15.75  0.1107     10550.8    4917.0
-16.00  0.1107     11382.8    5029.5
-16.25  0.1107     25263.5    7589.9
-16.50  0.1107     25083.1    7541.4
-17.00  0.1107     24669.3    7143.7
-18.00  0.1107     24880.5    7160.0
-19.00  0.1107     24557.9    7055.2
-20.00  0.1107     23730.5    7207.3
-21.00  0.1107     23773.8    7054.9
-22.00  0.1107     23441.2    7042.8
```

4.4 C5 Clean -

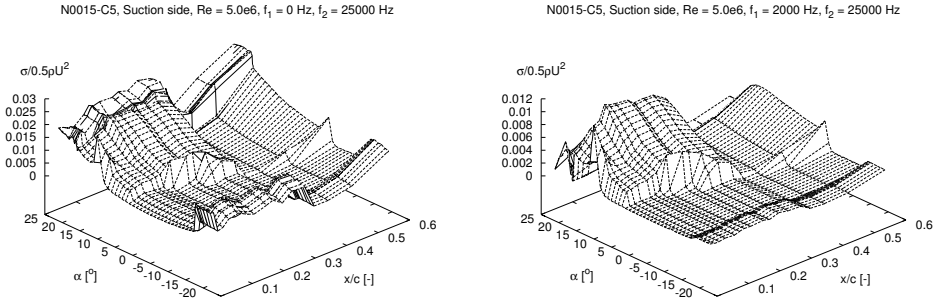

Figure 19: Pressure standard deviations, σ

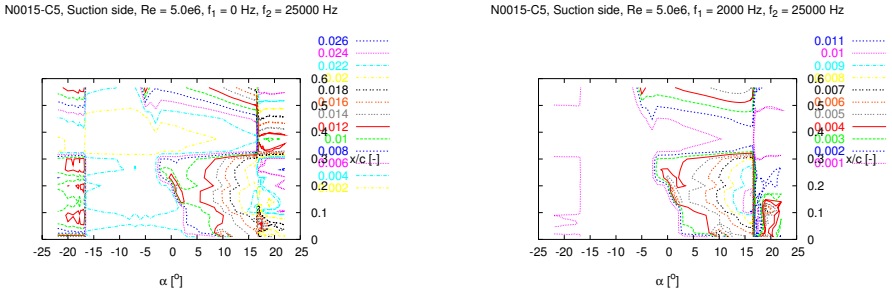

Figure 20: Contours of σ

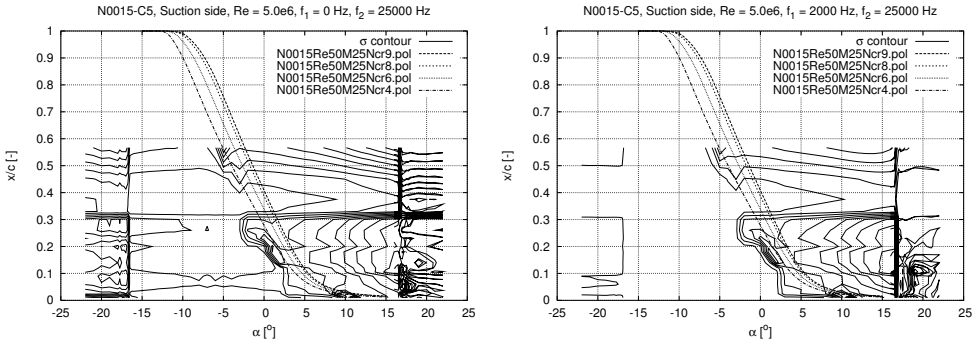

Figure 21: Contours of σ and XFoil data

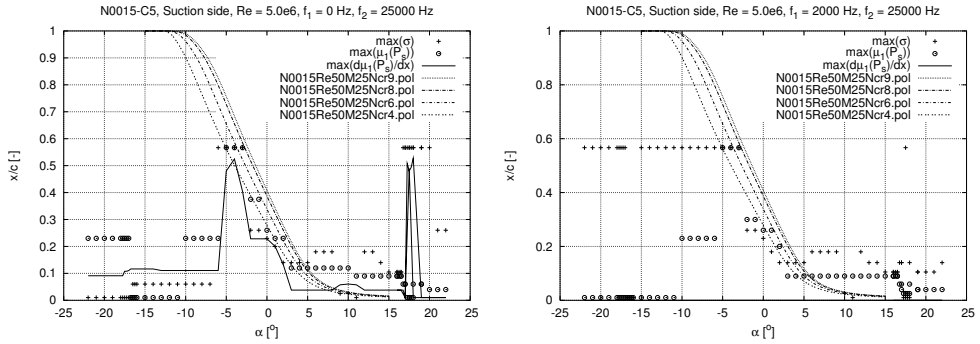

Figure 22: Transition detection

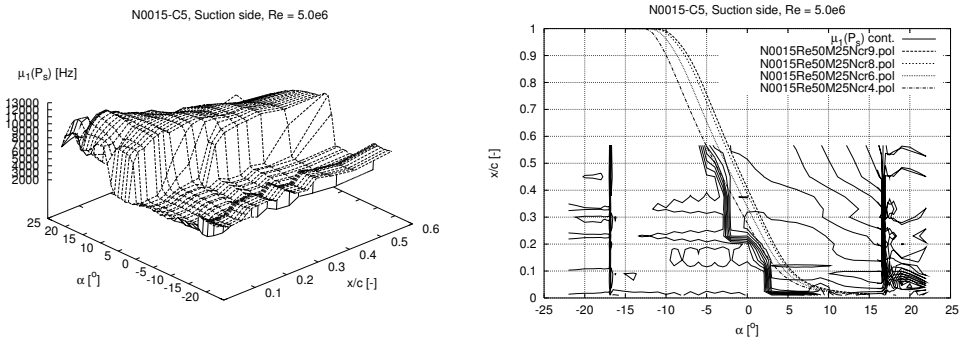

Figure 23: Fourier transform mean, $\mu_1(P_s)$

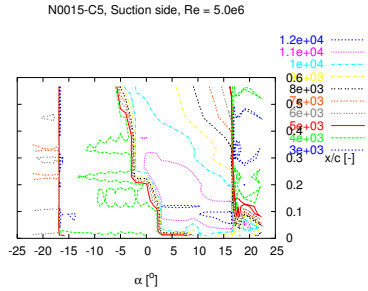

Figure 24: Contours of $\mu_1(P_s)$

```
N0015-C5
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.0380     72737.0   12391.3
 16.25  0.0380     72963.9   12361.9
 16.50  0.0380     72192.6   12346.5
 16.75  0.0380     60141.4   11885.5
 17.00  0.0100     31513.9   10878.8
 17.25  0.5079     12936.0    9830.8
 17.50  0.4799     12910.9    9511.4
 17.75  0.4939     12461.1    9551.3
 18.00  0.5275     12324.7   10083.6
 19.00  0.0100     31719.0   11277.5
 20.00  0.0100     39665.4   11084.2
 21.00  0.0100     39514.3   10715.5
 22.00  0.0100     37831.1    9863.5
 19.00  0.0100     28513.3   11256.4
 18.00  0.0100     12319.4   10314.2
 17.50  0.4883     11841.3    9757.2
 17.00  0.0100     24637.2   10219.5
 16.50  0.0380     71783.8   12315.5
 16.00  0.0380     69223.0   12325.0
```

15.00	0.0380	63955.8	12292.8
14.00	0.0380	57098.8	12255.7
13.00	0.0380	43666.9	12226.9
12.00	0.0380	28544.4	12200.9
11.00	0.0576	27527.2	12104.5
10.00	0.0604	34134.1	12018.1
9.00	0.0576	48159.7	12064.2
8.00	0.0380	101416.1	12114.2
7.00	0.0380	120870.2	12117.3
6.00	0.0380	124569.7	12136.5
5.00	0.0380	123354.8	12114.7
4.00	0.0380	126654.4	12090.0
3.00	0.0380	121141.8	12035.3
2.00	0.1331	89520.4	11908.0
1.00	0.2002	90107.9	11692.2
0.00	0.2282	114490.7	11305.7
-1.00	0.2282	115662.4	11002.2
-2.00	0.2282	114822.4	10938.6
-3.00	0.4044	53740.7	10609.0
-4.00	0.5247	56455.7	10566.9
-5.00	0.4799	37738.4	8157.2
-6.00	0.1107	12035.3	4289.7
-7.00	0.1107	13065.1	4494.2
-8.00	0.1107	12318.9	4250.7
-9.00	0.1107	13334.0	4399.9
-10.00	0.1107	12119.6	4122.6
-11.00	0.1107	12897.4	4875.2
-12.00	0.1107	11910.8	4711.8
-13.00	0.1107	12332.0	4852.7
-14.00	0.1163	11382.5	4654.1
-15.00	0.1163	11759.3	4840.2
-16.00	0.1163	11042.9	5038.4
-16.25	0.1163	10021.4	5101.3
-16.50	0.1163	11077.9	5108.3
-16.75	0.1163	10674.4	4740.4
-17.00	0.1107	22295.5	7261.1
-17.25	0.1079	22202.6	7262.9
-17.50	0.1079	22028.6	7294.3
-17.75	0.0911	21769.5	7259.2
-18.00	0.0911	21284.0	7203.4
-19.00	0.0911	21441.3	7234.3
-20.00	0.0911	21432.8	7232.2
-21.00	0.0911	21534.1	7337.9
-22.00	0.0911	21681.4	7411.3

4.5 C6 Clean -

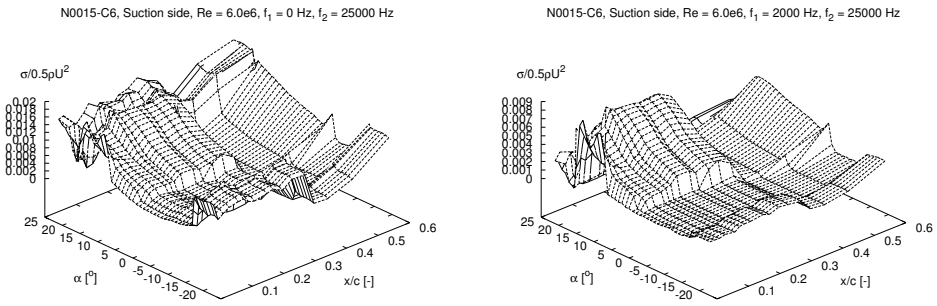

Figure 25: Pressure standard deviations, σ

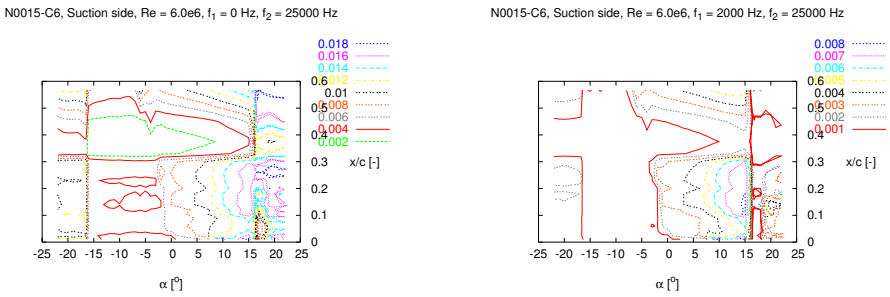

Figure 26: Contours of σ

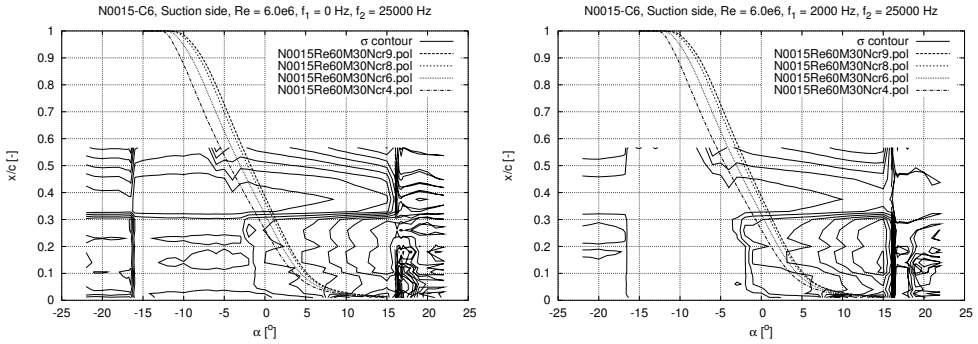

Figure 27: Contours of σ and XFoil data

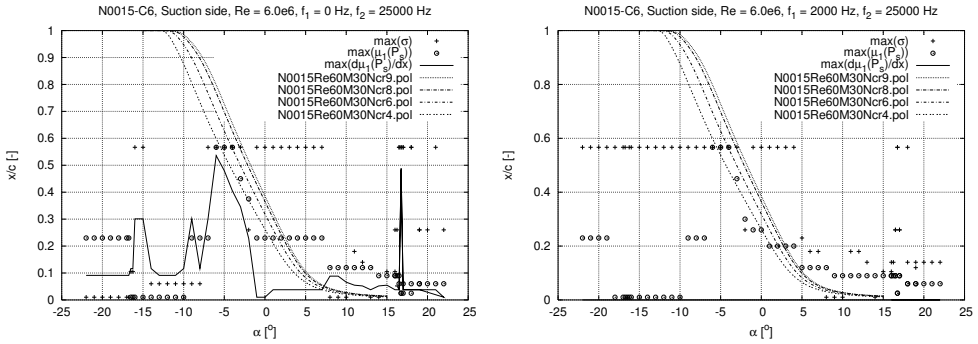

Figure 28: Transition detection

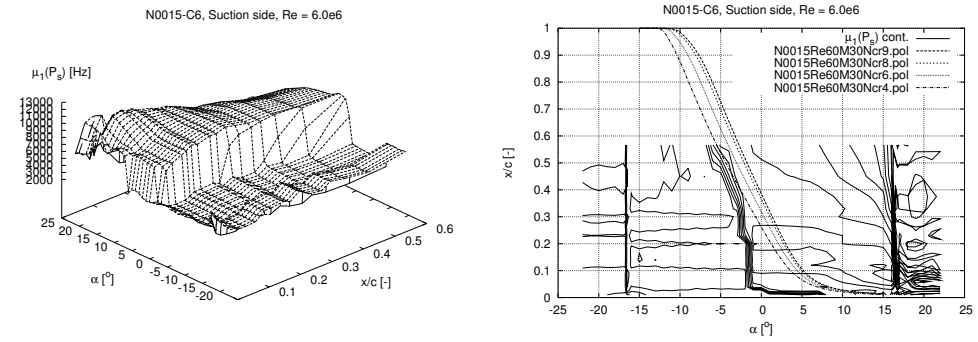

Figure 29: Fourier transform mean, $\mu_1(P_s)$

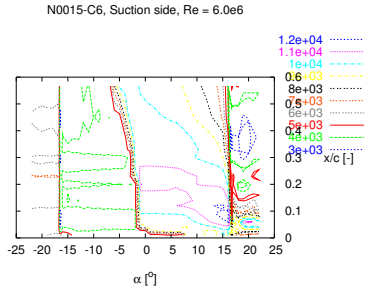

Figure 30: Contours of $\mu_1(P_s)$

```
N0015-C6
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
16.00	0.0520	39179.1	12361.3
16.25	0.0520	45812.2	12200.3
16.50	0.0380	27820.5	10031.4
16.75	0.4799	13355.0	9152.6
17.00	0.0380	19981.1	9799.2
18.00	0.0380	35285.0	8906.6
19.00	0.0380	48391.3	10618.3
20.00	0.0380	64823.8	11193.0
21.00	0.0380	64099.5	10937.5
22.00	0.0100	60368.4	10462.2
19.00	0.0380	62110.9	11473.8
18.00	0.0380	23673.6	9342.2
17.00	0.0380	18238.5	10013.0
16.75	0.4883	13975.8	9221.8
16.50	0.0380	33926.6	10663.3
16.00	0.0380	59182.9	12247.5
15.00	0.0548	42603.4	12219.4
14.00	0.0520	51220.7	12080.6
13.00	0.0380	52668.0	11951.4
12.00	0.0520	42415.7	11863.7
11.00	0.0548	33699.1	11698.6
10.00	0.0659	25608.5	11599.7
9.00	0.0883	26641.8	11417.6
8.00	0.0883	31011.5	11202.7
7.00	0.0380	91708.0	11212.5
6.00	0.0380	81758.2	11224.5
5.00	0.0380	78296.6	11262.2
4.00	0.0380	81480.2	11314.9
3.00	0.0380	87035.4	11333.0
2.00	0.0380	89942.0	11377.2
1.00	0.0380	90411.9	11370.3
0.00	0.0100	108740.8	11385.4
-1.00	0.0100	100672.2	11385.6
-2.00	0.2282	99386.0	10794.5
-3.00	0.3457	52140.4	10598.0
-4.00	0.4044	47513.3	10501.4
-5.00	0.4799	51923.7	10355.0
-6.00	0.5359	32303.1	7879.4
-7.00	0.3009	10573.0	4538.3
-8.00	0.1163	10894.3	4691.0
-9.00	0.3009	10503.2	4505.0
-10.00	0.1163	11581.6	4935.3
-11.00	0.0911	10450.4	4983.3
-12.00	0.0911	11760.7	4693.8
-13.00	0.0911	10767.9	4480.0
-14.00	0.1163	11225.4	4844.8
-15.00	0.3009	9860.8	5586.5
-16.00	0.3009	10838.2	5673.2
-16.25	0.1163	10686.0	6068.9
-16.50	0.1163	12751.8	6111.5
-16.75	0.0911	20487.5	7162.8
-17.00	0.0911	20076.1	7069.0
-18.00	0.0911	19759.4	7124.0
-19.00	0.0911	19948.4	7100.1
-20.00	0.0911	20110.0	7041.6
-21.00	0.0911	19909.0	7041.9
-22.00	0.0911	19974.5	7119.0

4.6 Z16 ZZ90 x/c=5% suc. x/c=10% press. -

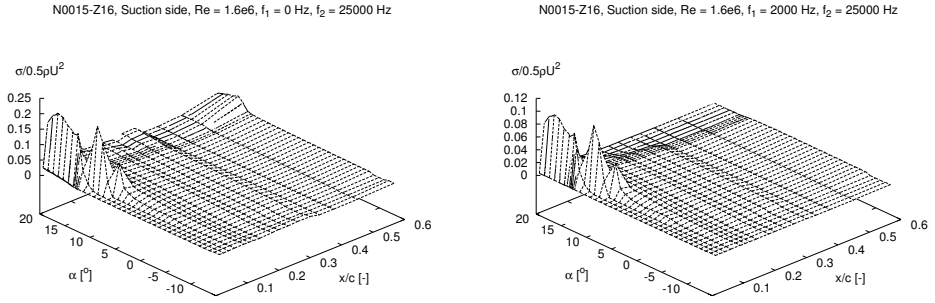

Figure 31: Pressure standard deviations, σ

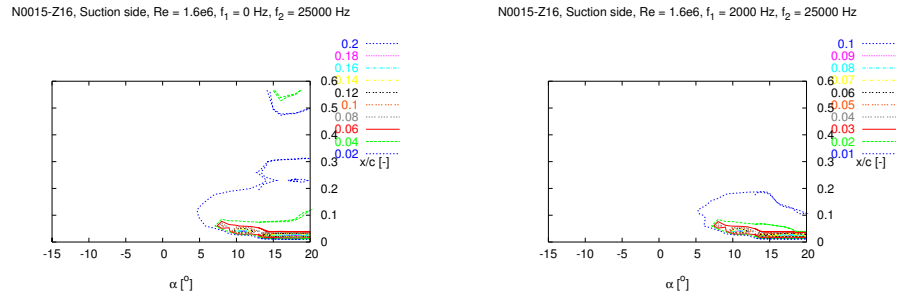

Figure 32: Contours of σ

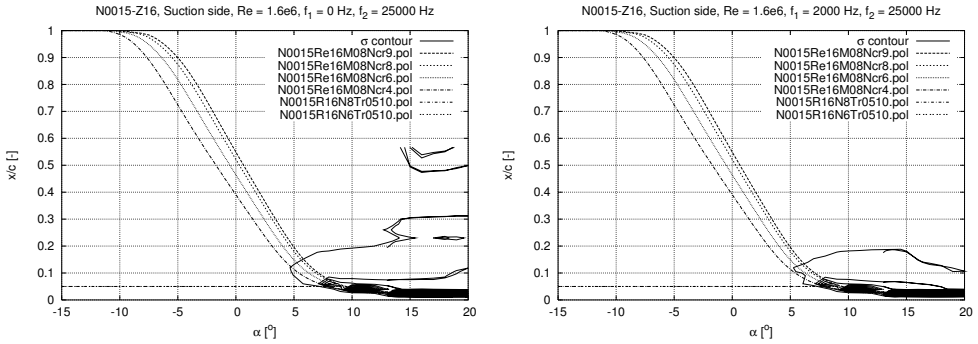

Figure 33: Contours of σ and XFoil data

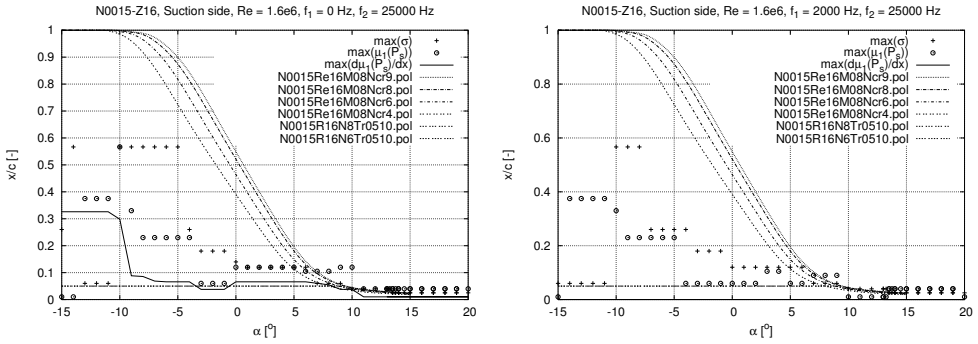

Figure 34: Transition detection

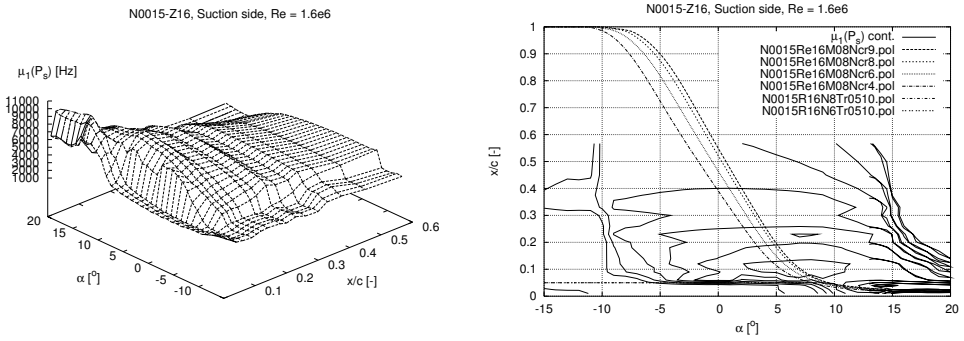

Figure 35: Fourier transform mean, $\mu_1(P_s)$

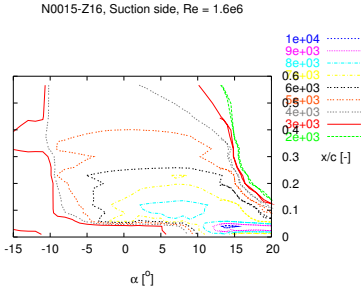

Figure 36: Contours of $\mu_1(P_s)$

```
N0015-Z16
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 13.00  0.0100     22296.7    9427.0
 13.25  0.0100     24970.2    9838.6
 13.50  0.0100     26357.6   10075.2
 13.75  0.0100     27769.4   10218.5
 14.00  0.0100     25852.6   10300.8
 15.00  0.0100     41144.1   10129.8
 16.00  0.0100     39439.5    9847.9
 17.00  0.0100     38508.0    9695.4
 18.00  0.0100     34278.3    9622.5
 19.00  0.0100     29437.6    9488.4
 20.00  0.0100     23363.9    9271.6
 19.00  0.0100     28902.8    9361.8
 18.00  0.0100     34386.7    9642.6
 17.00  0.0100     38557.8    9758.8
 16.00  0.0100     40252.5    9847.4
 15.00  0.0100     42595.9   10148.8
 14.50  0.0100     54629.5   10278.3
 14.00  0.0100     33677.8   10302.4
 13.50  0.0100     26758.7   10171.4
 13.00  0.0100     22224.8    9833.3
 12.00  0.0100     12019.3    8916.4
 11.00  0.0100     21699.7    8536.1
 10.00  0.0380     27224.7    8265.2
  9.00  0.0380     61638.7    8492.2
  8.00  0.0548     78131.9    8768.1
  7.00  0.0604     87656.9    8655.6
  6.00  0.0659     90203.2    8595.1
  5.00  0.0659     89385.0    8364.1
  4.00  0.0659     91398.3    8297.2
  3.00  0.0659     90060.4    8155.2
  2.00  0.0659     89253.1    7963.2
  1.00  0.0659     87241.5    7787.1
  0.00  0.0659     83512.0    7574.0
 -1.00  0.0380     79248.3    7413.8
 -2.00  0.0380     74756.8    7013.1
 -3.00  0.0380     64324.9    6484.1
 -4.00  0.0659     61878.6    6162.2
 -5.00  0.0659     52281.1    6007.9
 -6.00  0.0659     46814.3    5864.4
 -7.00  0.0687     38033.4    5696.1
 -8.00  0.0855     34354.6    5519.8
 -9.00  0.0883     28401.2    5139.9
-10.00  0.2981     20143.5    4421.0
-11.00  0.3261     24645.0    3709.2
-12.00  0.3261     24552.7    3659.7
-13.00  0.3261     24064.4    3687.4
-14.00  0.3261     14058.7    3582.5
-15.00  0.3261     13172.4    3901.7
```

4.7 Z3 ZZ90 x/c=5% suc. x/c=10% press. -

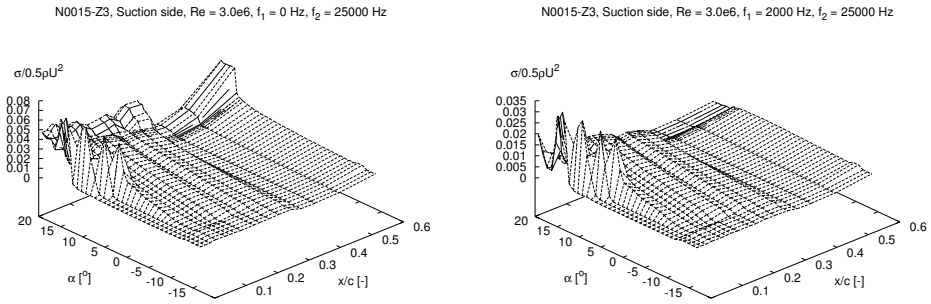

Figure 37: Pressure standard deviations, σ

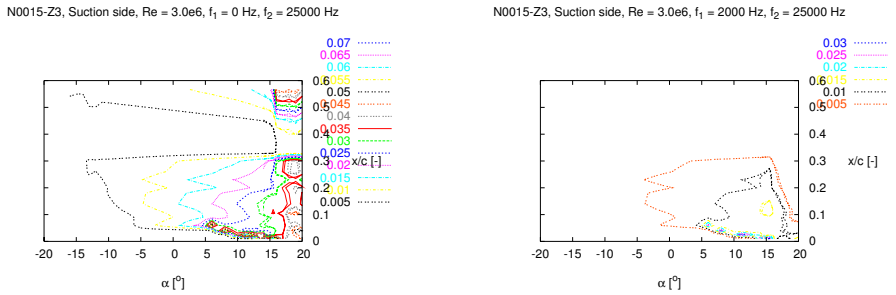

Figure 38: Contours of σ

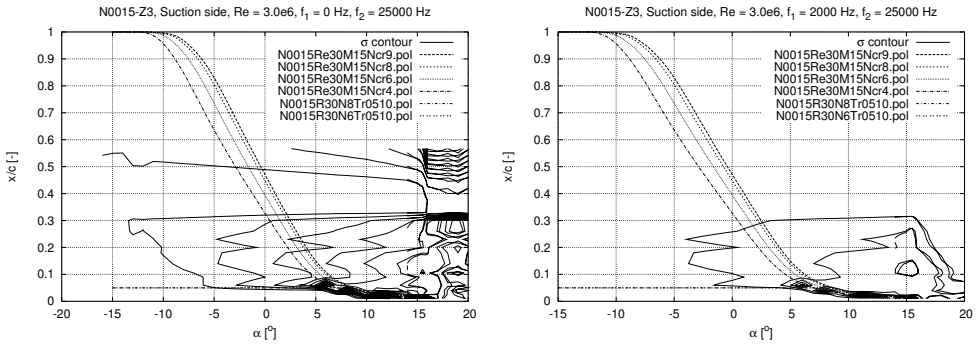

Figure 39: Contours of σ and XFoil data

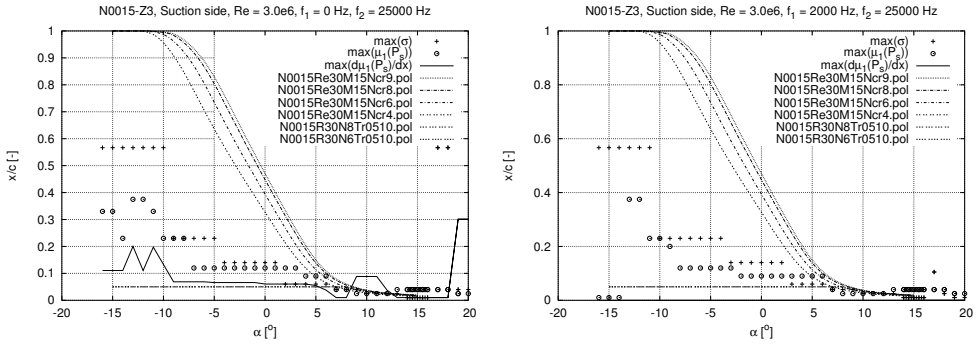

Figure 40: Transition detection

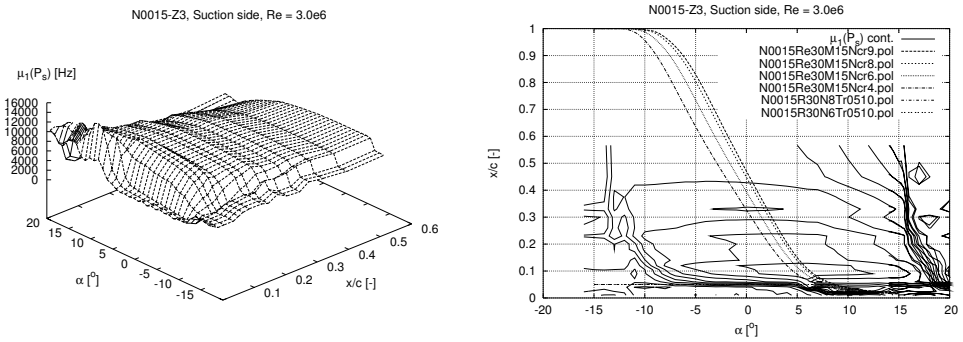

Figure 41: Fourier transform mean, $\mu_1(P_s)$

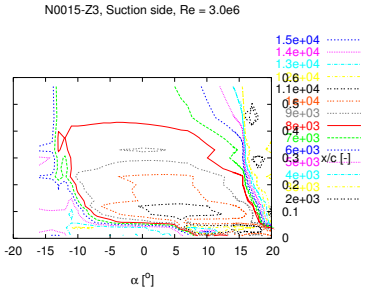

Figure 42: Contours of $\mu_1(P_s)$

```
N0015-Z3
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 14.00  0.0100     40246.0   12537.9
 14.25  0.0100     37974.4   12729.8
 14.50  0.0100     38504.0   12815.0
 14.75  0.0100     33614.1   12934.0
 15.00  0.0100     40512.4   12835.7
 15.25  0.0100     41446.8   12718.8
 15.50  0.0100     39802.6   12528.8
 15.75  0.0100     38183.3   12235.2
 16.00  0.0100     34422.1   12030.7
 17.00  0.0100     36367.4   12077.8
 18.00  0.0100     25762.4   11451.0
 19.00  0.3009     12702.3   10835.3
 20.00  0.3009     16233.1   10354.7
 19.00  0.3009     13955.5   10584.2
 18.00  0.0100     32379.0   11710.9
 17.00  0.0100     39508.4   12096.7
 16.00  0.0100     35210.8   12046.7
 15.50  0.0100     40129.9   12630.3
 15.00  0.0100     41229.3   12643.8
```

14.50	0.0100	40265.9	12512.0
14.00	0.0100	41516.6	11635.2
13.00	0.0100	54823.4	12639.5
12.00	0.0380	45382.9	12280.8
11.00	0.0883	29173.2	14878.9
10.00	0.0883	31997.0	15226.0
9.00	0.0883	33948.7	14438.5
8.00	0.0100	71659.0	13105.9
7.00	0.0100	151977.5	13118.1
6.00	0.0380	104207.5	11903.3
5.00	0.0548	114722.4	11684.0
4.00	0.0604	121794.2	11515.9
3.00	0.0604	120154.0	11351.3
2.00	0.0604	120491.7	11258.1
1.00	0.0604	118104.3	11150.7
0.00	0.0604	119323.1	11056.2
-1.00	0.0659	116203.7	10979.6
-2.00	0.0659	117662.1	10842.8
-3.00	0.0659	111262.7	10705.9
-4.00	0.0659	112356.0	10576.4
-5.00	0.0659	106163.4	10399.5
-6.00	0.0687	105600.7	10147.0
-7.00	0.0687	94323.3	9747.0
-8.00	0.0687	82842.9	9579.8
-9.00	0.0687	53648.2	9508.8
-10.00	0.1331	46815.4	9323.7
-11.00	0.1974	38667.1	8595.6
-12.00	0.1107	19771.8	7982.9
-13.00	0.2002	30395.4	8192.5
-14.00	0.1107	19703.4	6294.1
-15.00	0.1107	21214.6	6227.7
-16.00	0.1107	21065.2	6148.4

4.8 Z6 ZZ90 x/c=5% suc. x/c=10% press. -

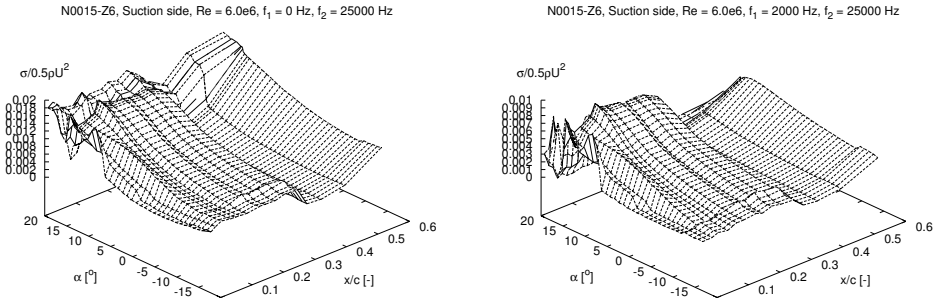

Figure 43: Pressure standard deviations, σ

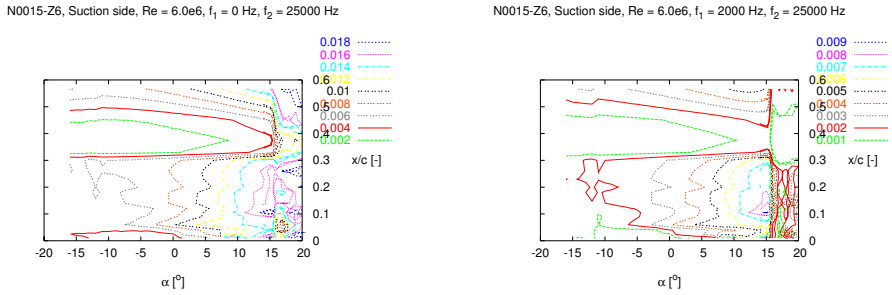

Figure 44: Contours of σ

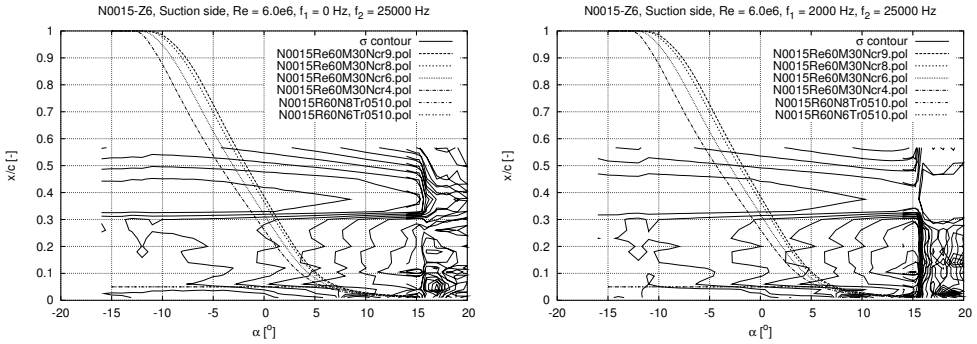

Figure 45: Contours of σ and XFoil data

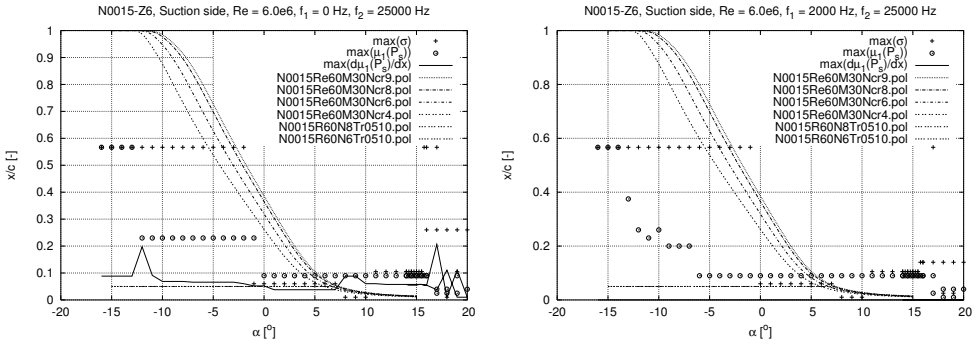

Figure 46: Transition detection

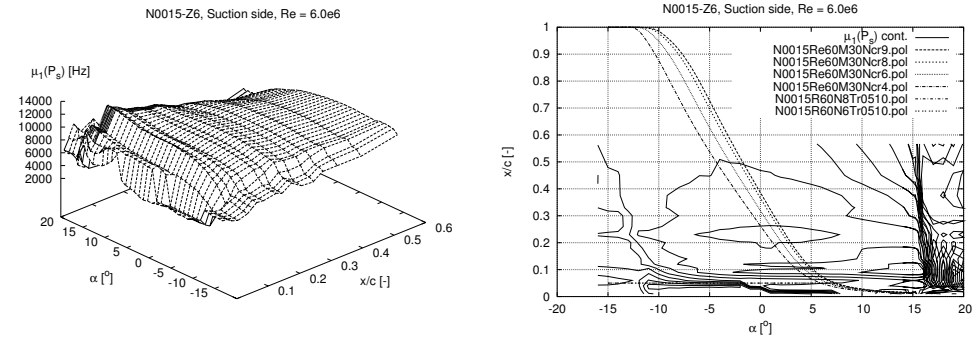

Figure 47: Fourier transform mean, $\mu_1(P_s)$

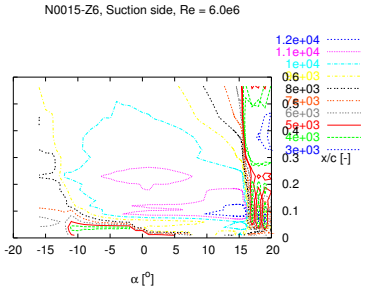

Figure 48: Contours of $\mu_1(P_s)$

```
N0015-Z6
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
14.00	0.0576	55323.0	12814.1
14.25	0.0548	55231.0	12848.0
14.50	0.0548	55496.9	12869.7
14.75	0.0548	52987.0	12869.3
15.00	0.0548	51471.7	12872.3
15.25	0.0576	45899.0	12802.2
15.50	0.0576	50216.5	12901.2
15.75	0.0548	56364.2	12997.7
16.00	0.0548	52887.0	12778.3
17.00	0.2058	14799.3	8845.2
18.00	0.0100	26168.8	8486.5
19.00	0.1107	21452.1	6857.1
20.00	0.0100	55712.7	9720.8
19.00	0.0100	51608.1	9853.2
18.00	0.1107	20008.4	8391.9
17.00	0.0380	29244.2	8924.1
16.00	0.0548	49279.5	12586.4
15.50	0.0576	48991.2	12868.8
15.00	0.0576	49709.2	12837.0
14.50	0.0576	53792.6	12841.1
14.00	0.0576	55653.4	12777.3
13.00	0.0576	55065.6	12622.3
12.00	0.0576	51801.0	12419.5
11.00	0.0604	47104.1	12237.0
10.00	0.0604	43180.8	12019.6
9.00	0.0883	42937.5	11794.2
8.00	0.0883	42339.6	11639.2
7.00	0.0380	65943.7	11636.0
6.00	0.0380	73921.9	11538.3
5.00	0.0380	75159.8	11507.0
4.00	0.0380	78968.5	11517.9
3.00	0.0380	84651.8	11515.8
2.00	0.0380	87933.1	11533.4
1.00	0.0380	84513.8	11509.1
0.00	0.0520	109116.7	11374.2
-1.00	0.0520	104980.0	11332.0
-2.00	0.0604	119969.5	11322.2
-3.00	0.0659	116997.3	11276.2
-4.00	0.0659	115289.8	11239.3
-5.00	0.0659	109616.9	11130.3
-6.00	0.0659	105636.8	11062.9
-7.00	0.0659	98375.5	10911.9
-8.00	0.0687	91964.8	10804.2
-9.00	0.0687	83715.9	10646.7
-10.00	0.0687	74030.8	10471.3
-11.00	0.0911	60005.3	10284.2
-12.00	0.1974	28988.3	10138.6
-13.00	0.0883	26455.7	9884.2
-14.00	0.0883	26896.1	9780.6
-15.00	0.0883	26860.9	9682.6
-16.00	0.0883	26204.1	9041.7

4.9 T16 Trip wire. Bump tape 2% -

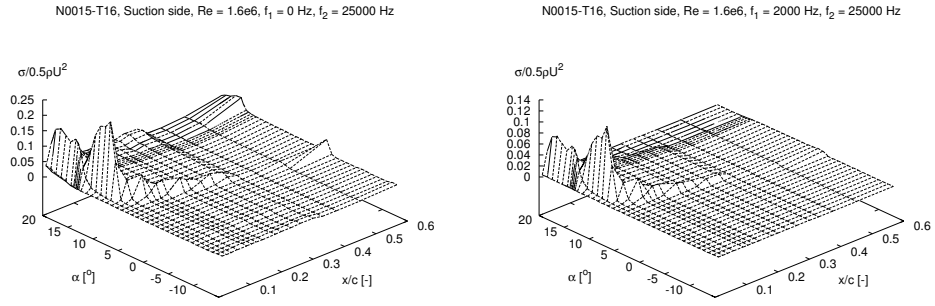

Figure 49: Pressure standard deviations, σ

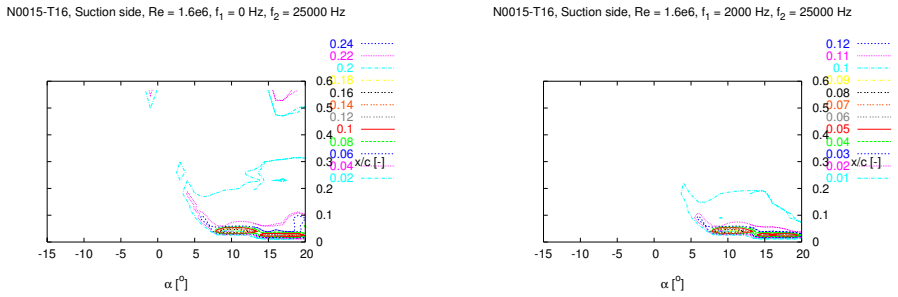

Figure 50: Contours of σ

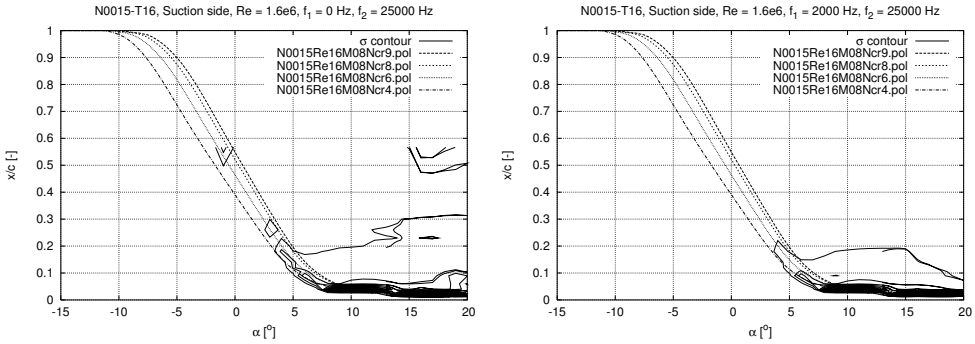

Figure 51: Contours of σ and XFoil data

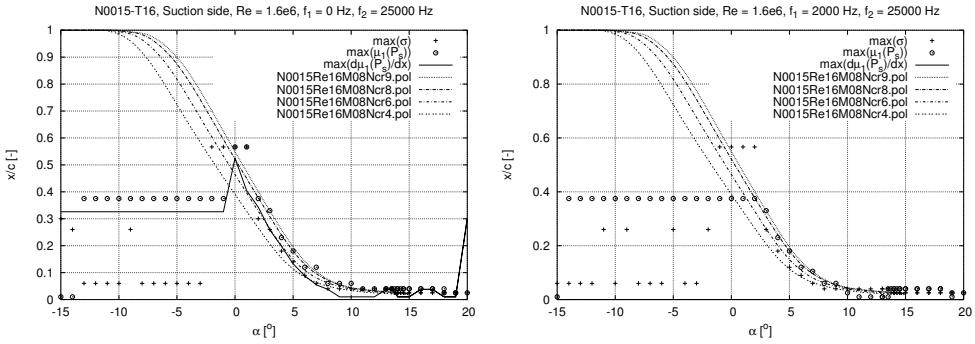

Figure 52: Transition detection

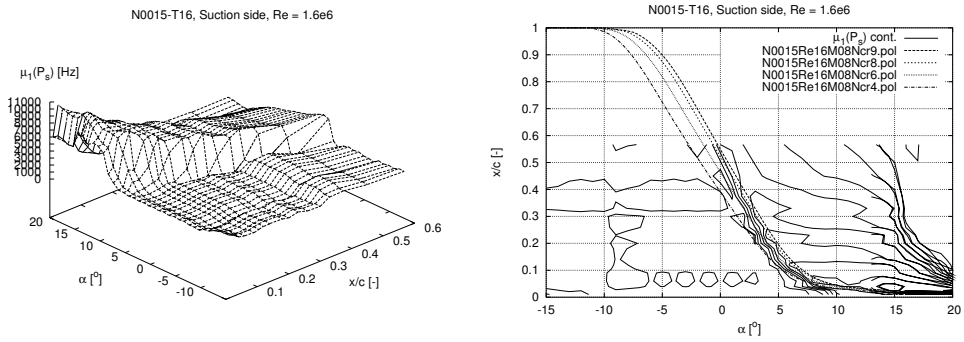

Figure 53: Fourier transform mean, $\mu_1(P_s)$

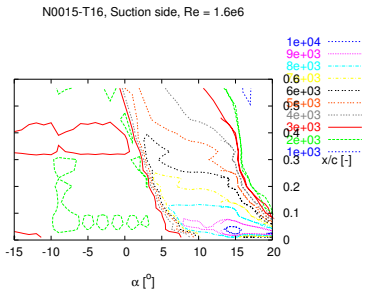

Figure 54: Contours of $\mu_1(P_s)$

```
N0015-T16
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 13.00  0.0380     29235.3    9147.5
 13.50  0.0380     33545.5    9762.3
 13.75  0.0380     31123.0   10082.1
 14.00  0.0100     30291.0   10306.6
 14.25  0.0100     28391.8   10442.5
 14.50  0.0100     30830.8   10484.4
 15.00  0.0100     19790.6   10521.2
 16.00  0.0380     47861.9    9806.8
 17.00  0.0380     41798.0    9673.5
 18.00  0.0100     28854.9    9553.5
 19.00  0.0100     17508.3    9790.0
 20.00  0.3009      7316.4   10236.7
 19.00  0.0100     10045.8    9943.3
 18.00  0.0100     27556.0    9626.3
 17.00  0.0380     42346.0    9735.0
 16.00  0.0380     47080.6    9898.4
 15.00  0.0100     25225.2   10521.6
 14.50  0.0100     29351.3   10550.4
 14.00  0.0100     30684.9   10409.2
 13.50  0.0380     33592.9   10024.4
 13.00  0.0380     34110.9    9669.9
 12.00  0.0100     26248.1    9058.9
 11.00  0.0100     35721.8    9085.9
 10.00  0.0100     41887.3    9142.7
  9.00  0.0100     95557.1    9290.5
  8.00  0.0380    104880.7    9754.4
  7.00  0.0548     79768.7    8560.5
  6.00  0.0883     80663.2    8292.6
  5.00  0.1331     66281.6    7529.7
  4.00  0.1974     73891.4    7635.1
  3.00  0.2590     60835.5    6756.7
  2.00  0.3429     58090.0    5646.7
  1.00  0.4044     30970.7    5223.7
  0.00  0.5247     32434.6    5000.7
 -1.00  0.3261     25921.6    3653.3
 -2.00  0.3261     25168.4    3718.1
 -3.00  0.3261     25841.6    3624.5
 -4.00  0.3261     24859.5    3692.0
 -5.00  0.3261     26015.7    3655.4
 -6.00  0.3261     24805.9    3666.3
 -7.00  0.3261     24224.4    3419.0
 -8.00  0.3261     22758.7    3260.9
 -9.00  0.3261     22966.6    3134.5
-10.00  0.3261     24765.8    3713.3
-11.00  0.3261     25245.2    3631.8
-12.00  0.3261     24557.4    3715.0
-13.00  0.3261     24662.2    3643.1
-14.00  0.3261     13773.1    3661.6
-15.00  0.3261     14076.0    4135.6
```

4.10 T3 Trip wire. Bump tape 2% -

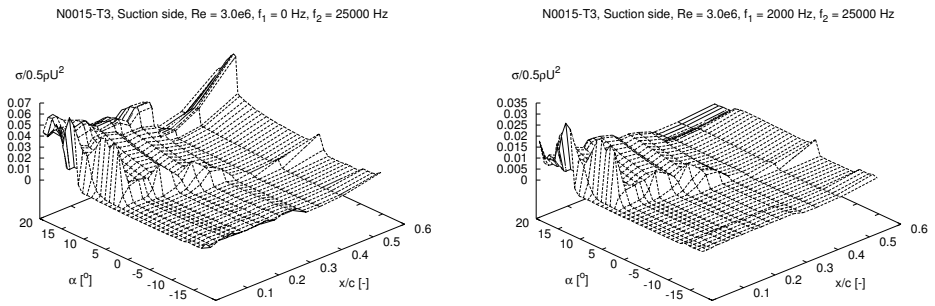

Figure 55: Pressure standard deviations, σ

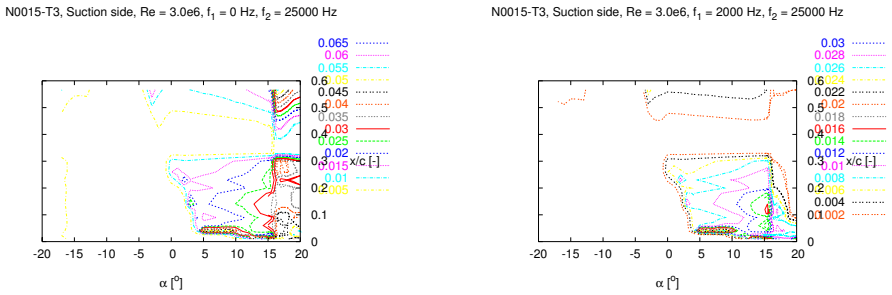

Figure 56: Contours of σ

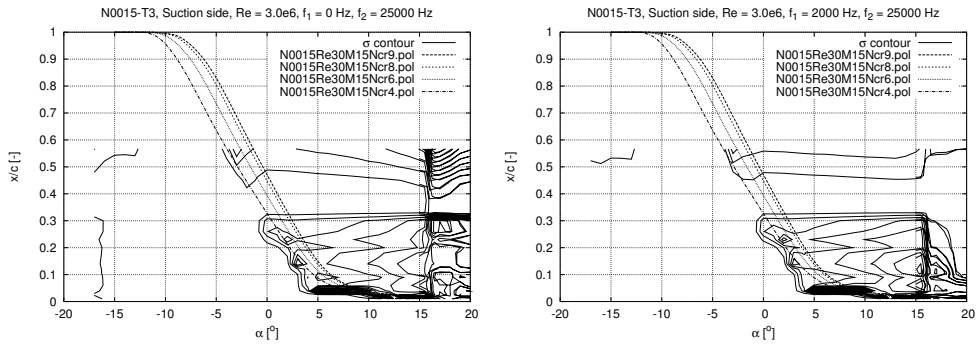

Figure 57: Contours of σ and XFoil data

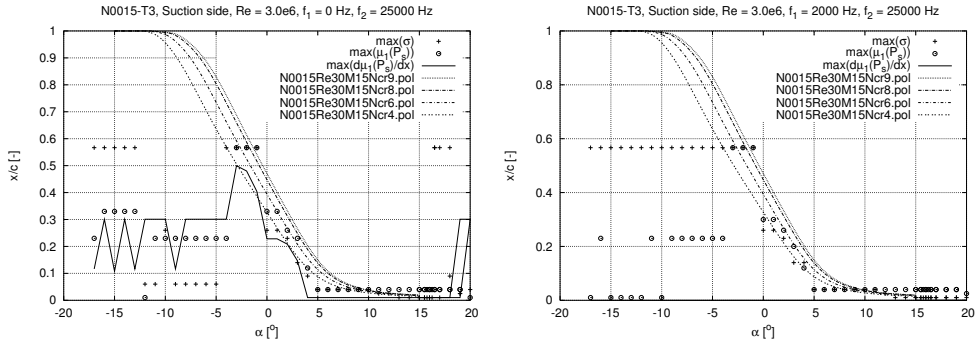

Figure 58: Transition detection

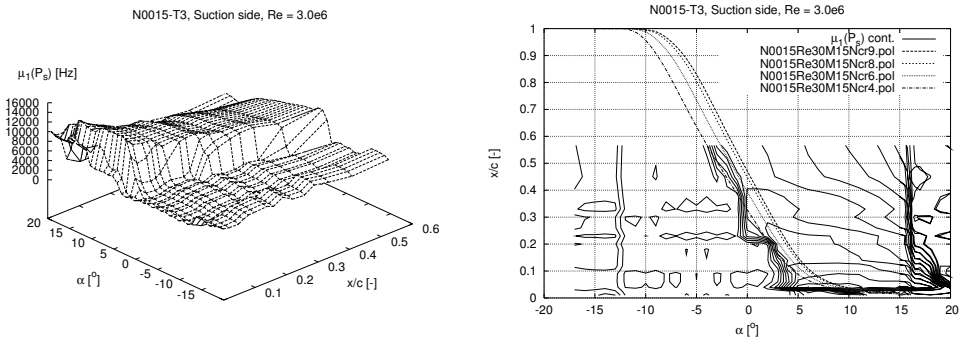

Figure 59: Fourier transform mean, $\mu_1(P_s)$

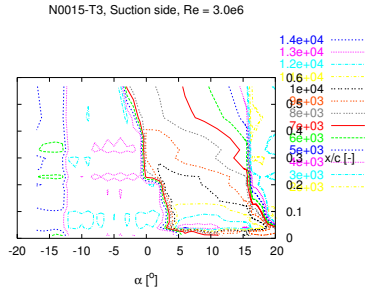

Figure 60: Contours of $\mu_1(P_s)$

```
N0015-T3
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 15.00  0.0100     77880.8   13063.9
 15.50  0.0100     75269.5   13113.7
 15.75  0.0100     74839.0   13099.1
 16.00  0.0100     73823.9   12903.6
 16.25  0.0100     71742.3   12004.9
 16.50  0.0100     67904.2   11756.5
 17.00  0.0100     67274.8   11686.5
 18.00  0.0100     59006.9   11286.3
 19.00  0.0100     16659.8    9618.1
 20.00  0.3009     17849.7    9765.1
 19.00  0.3009     17354.5    9338.9
 18.00  0.0100     57427.4   11199.4
 17.00  0.0100     69530.8   11776.4
 16.50  0.0100     70551.8   11958.5
 16.00  0.0100     74684.3   12252.4
 15.50  0.0100     66324.3   13182.9
 15.00  0.0100     77949.3   13094.6
 14.00  0.0100     81720.5   12541.7
 13.00  0.0100     77554.3   12354.2
```

12.00	0.0100	79153.6	12310.0
11.00	0.0100	101976.9	13233.1
10.00	0.0100	113453.2	13965.1
9.00	0.0100	120159.2	13610.9
8.00	0.0100	158387.0	13896.2
7.00	0.0100	163588.9	13724.4
6.00	0.0100	159822.7	14017.0
5.00	0.0100	175990.3	13419.7
4.00	0.0100	159672.6	10945.5
3.00	0.1471	81016.5	10722.6
2.00	0.2086	110470.6	10255.8
1.00	0.2282	105716.0	9649.9
0.00	0.2282	86097.8	9517.6
-1.00	0.4044	63999.5	8869.1
-2.00	0.4799	38866.4	8918.2
-3.00	0.4995	38543.4	7260.7
-4.00	0.3009	14795.7	4441.1
-5.00	0.3009	14092.2	4145.1
-6.00	0.3009	14608.0	4420.1
-7.00	0.3009	13491.4	4020.5
-8.00	0.3009	14199.1	4287.3
-9.00	0.1163	11945.1	3812.8
-10.00	0.3009	14097.8	4007.3
-11.00	0.3009	12248.7	3765.5
-12.00	0.3009	12696.7	3960.5
-13.00	0.1163	19602.3	6242.1
-14.00	0.3009	19264.6	6346.4
-15.00	0.1079	20529.1	6336.1
-16.00	0.3009	19815.5	6256.6
-17.00	0.1163	19355.6	5969.5

4.11 T6 Trip wire. Bump tape 2% -

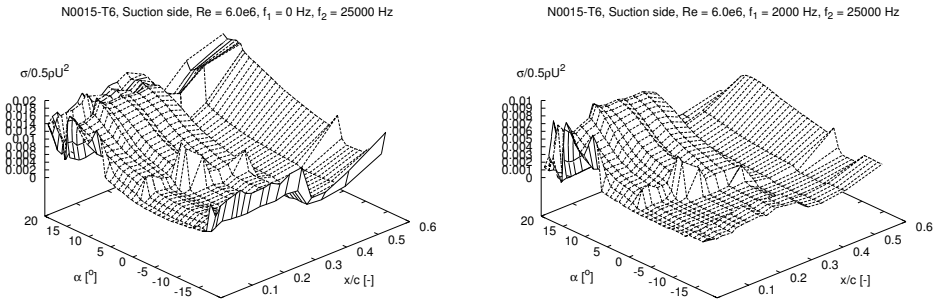

Figure 61: Pressure standard deviations, σ

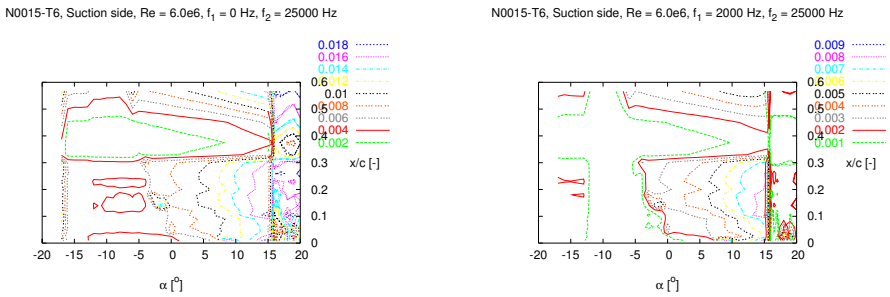

Figure 62: Contours of σ

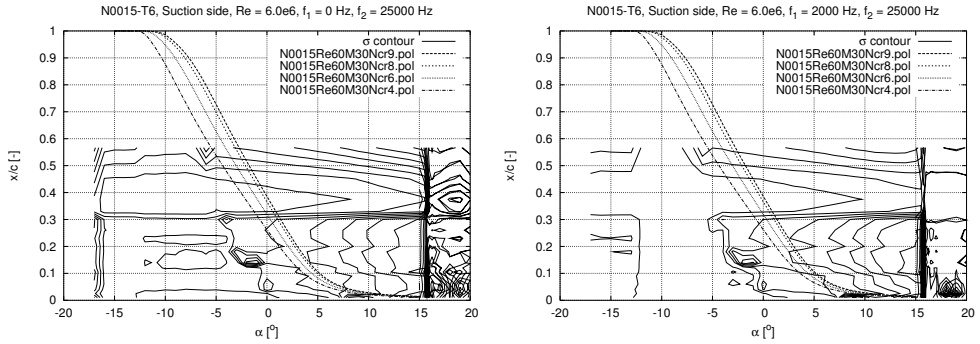

Figure 63: Contours of σ and XFoil data

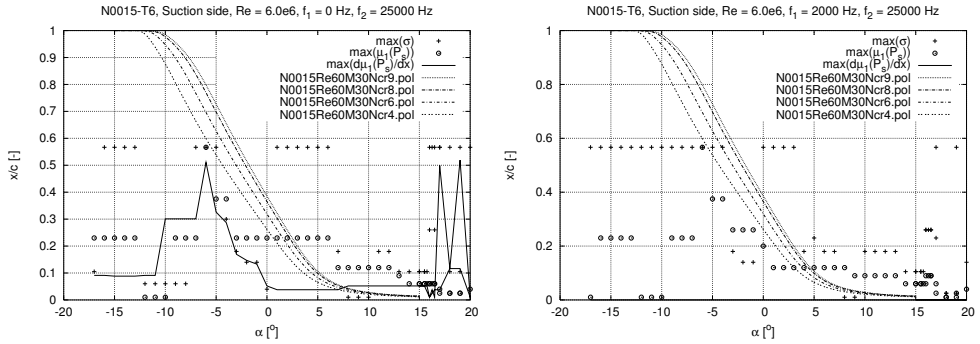

Figure 64: Transition detection

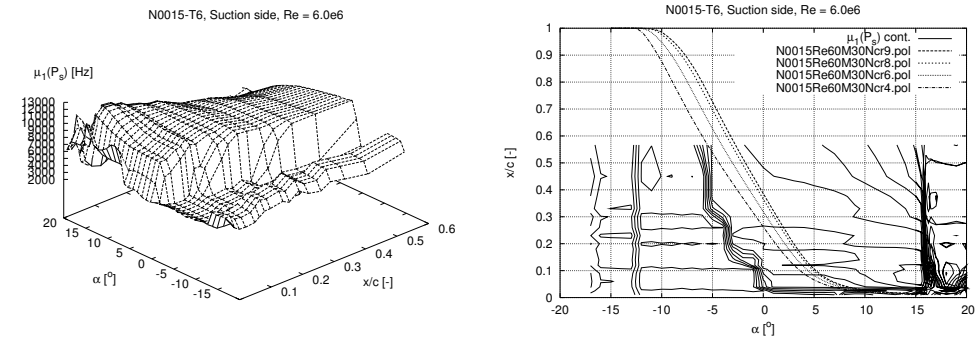

Figure 65: Fourier transform mean, $\mu_1(P_s)$

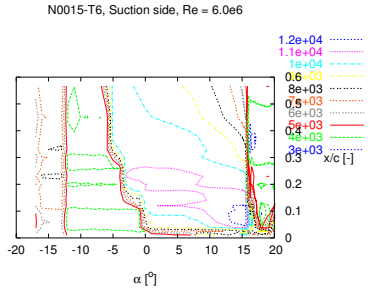

Figure 66: Contours of $\mu_1(P_s)$

N0015-T6
alpha [degrees] angle of attack
xtr* [-] transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx* [Hz/-] d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1) [Hz] max mu1 of all chordwise positions

alpha	xtr*	d(mu1)/dx*	max(mu1)
15.00	0.0520	77927.6	12663.2
15.50	0.0520	71531.9	12732.3
15.75	0.0520	70449.5	12771.5
16.00	0.0100	68149.7	11459.0
16.25	0.0380	18422.1	9330.9
16.50	0.0100	57517.4	11073.7
17.00	0.4995	13313.8	8432.8
18.00	0.1163	16360.6	9538.5
19.00	0.1163	21808.7	8878.6
20.00	0.0100	104762.5	10502.6
19.00	0.5191	13318.3	9040.5
18.00	0.1163	20455.0	9555.6
17.00	0.0380	21243.3	8501.0
16.50	0.0380	35842.1	10534.3
16.00	0.0100	19086.7	10076.7
15.50	0.0520	66909.0	12698.2
15.00	0.0520	69595.4	12619.6
14.00	0.0520	81551.0	12366.7
13.00	0.0520	82612.2	12049.9
12.00	0.0520	78845.0	11864.4
11.00	0.0520	72771.8	11726.2
10.00	0.0520	65369.7	11596.4
9.00	0.0520	60269.1	11464.5
8.00	0.0520	60346.1	11315.6
7.00	0.0380	84274.8	11240.5
6.00	0.0380	84476.3	11174.9
5.00	0.0380	81619.9	11215.0
4.00	0.0380	83832.6	11269.8
3.00	0.0380	90870.1	11304.6
2.00	0.0380	92704.7	11318.7
1.00	0.0380	93053.3	11345.4
0.00	0.0520	79999.2	11376.0
-1.00	0.1331	89077.2	11320.1
-2.00	0.1471	88584.1	11251.1
-3.00	0.1694	75565.4	11043.3
-4.00	0.2869	92277.7	10686.2
-5.00	0.3261	76139.6	10467.7
-6.00	0.5107	32760.6	7953.1
-7.00	0.3009	10419.0	4536.5
-8.00	0.3009	10970.1	4686.8
-9.00	0.3009	10391.1	4519.7
-10.00	0.3009	10903.1	4928.7
-11.00	0.0911	10431.1	4953.1
-12.00	0.0911	11538.1	4677.3
-13.00	0.0883	22581.5	8331.1
-14.00	0.0883	22983.7	8291.2
-15.00	0.0883	23460.4	8252.6
-16.00	0.0911	22903.8	8179.4
-17.00	0.0911	20306.4	6965.7

4.12 C16a Clean 200x200

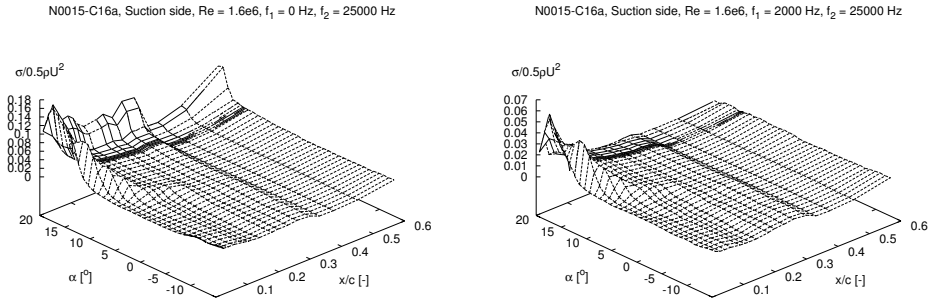

Figure 67: Pressure standard deviations, σ

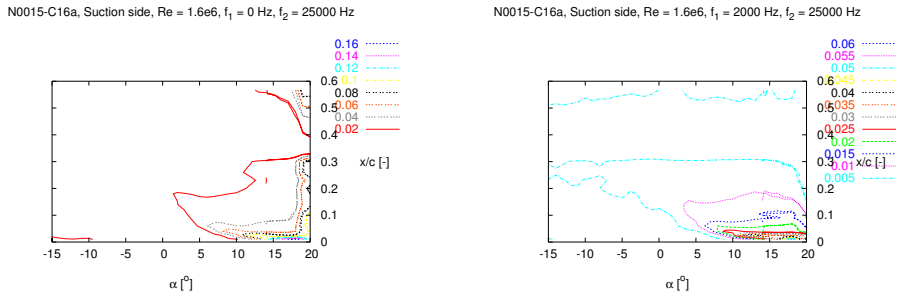

Figure 68: Contours of σ

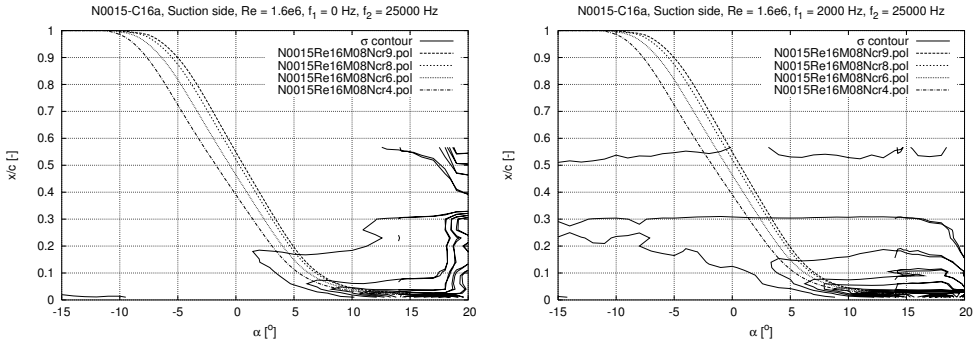

Figure 69: Contours of σ and XFoil data

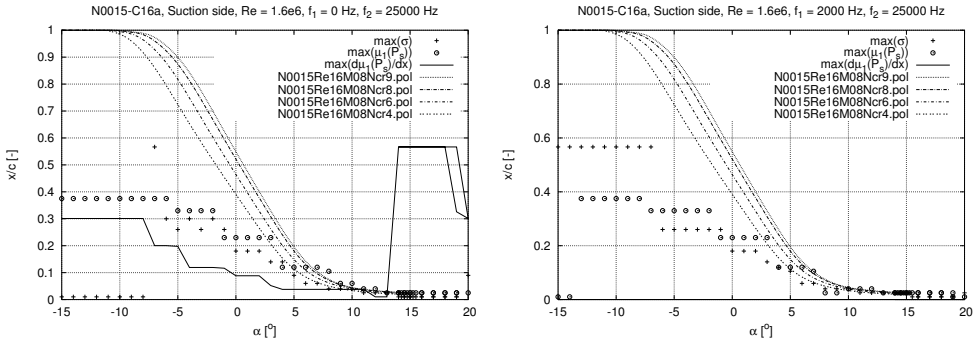

Figure 70: Transition detection

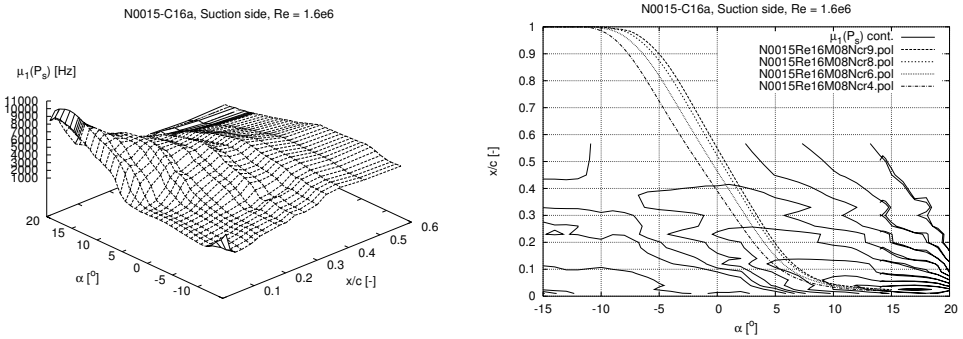

Figure 71: Fourier transform mean, $\mu_1(P_s)$

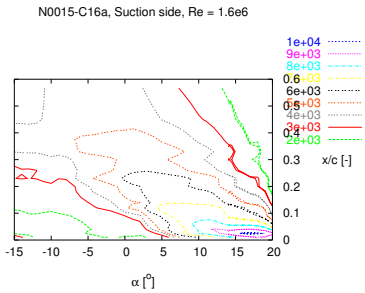

Figure 72: Contours of $\mu_1(P_s)$

```
N0015-C16a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 14.00  0.5667      1807.2    9271.2
 14.25  0.5667      1893.1    9581.9
 14.50  0.5667      1848.8    9658.0
 14.75  0.5667      1793.3    9730.8
 15.00  0.5667      1751.2    9819.8
 15.25  0.5667      1697.0    9908.0
 16.00  0.5667      1624.2   10131.0
 17.00  0.5667      1456.8   10269.9
 18.00  0.5667      1454.3   10132.6
 19.00  0.3261      1325.7    9850.7
 20.00  0.3009      3596.8    9290.0
 19.00  0.5667      1262.0    9832.0
 18.00  0.5667      1393.7   10002.5
 17.00  0.5667      1457.7   10185.8
 16.00  0.5667      1597.0   10054.5
 15.50  0.5667      1626.0    9961.9
 15.00  0.5667      1699.9    9818.8
 14.50  0.5667      1816.0    9627.5
 14.00  0.5667      1890.8    9487.1
 13.00  0.0100     11662.2    9083.0
 12.00  0.0100     24261.9    9041.2
 11.00  0.0380     31919.5    8753.5
 10.00  0.0380     33429.4    8225.8
  9.00  0.0380     38114.1    7985.3
  8.00  0.0380     36928.3    7801.4
  7.00  0.0380     39100.6    7809.6
  6.00  0.0380     53650.5    7708.8
  5.00  0.0380     56985.5    7410.7
  4.00  0.0380     52590.3    6823.3
  3.00  0.0520     42978.4    6901.9
  2.00  0.0883     46269.8    6657.7
  1.00  0.0883     47915.6    6536.9
  0.00  0.0883     43518.2    6198.7
 -1.00  0.1163     31457.1    5727.6
 -2.00  0.1191     28908.0    5495.0
 -3.00  0.1191     24643.4    5392.4
 -4.00  0.1191     20671.6    5289.6
 -5.00  0.1974     19421.9    5207.6
 -6.00  0.2002     21501.9    5090.1
 -7.00  0.2002     18331.3    4976.7
 -8.00  0.3009     21298.0    4813.1
 -9.00  0.3009     21270.1    4654.2
-10.00  0.3009     16665.5    4615.1
-11.00  0.3009     16475.0    4424.7
-12.00  0.3009     17401.0    4309.2
-13.00  0.3009     18113.2    4315.3
-14.00  0.3009     17711.2    4314.6
-15.00  0.3009     18100.7    4222.2
```

4.13 C3a Clean 200x200

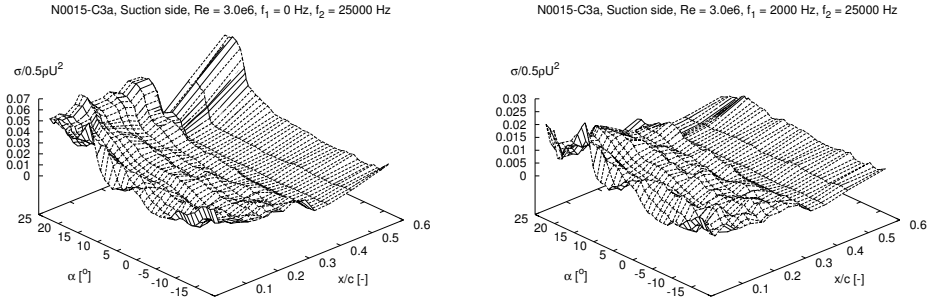

Figure 73: Pressure standard deviations, σ

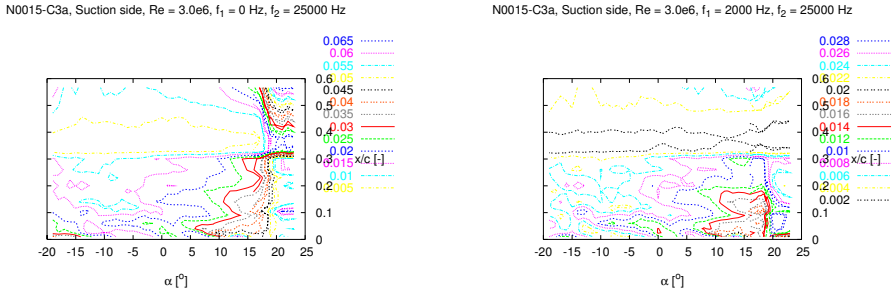

Figure 74: Contours of σ

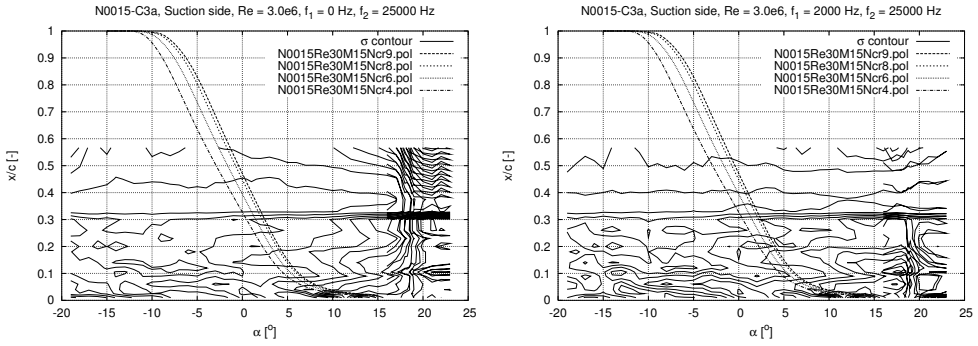

Figure 75: Contours of σ and XFoil data

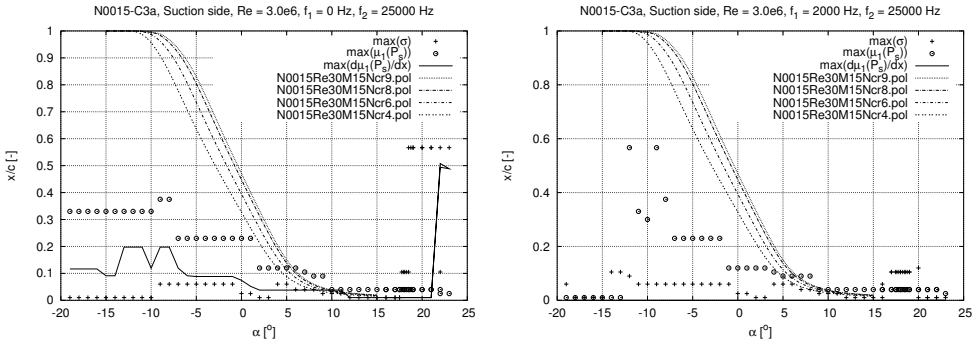

Figure 76: Transition detection

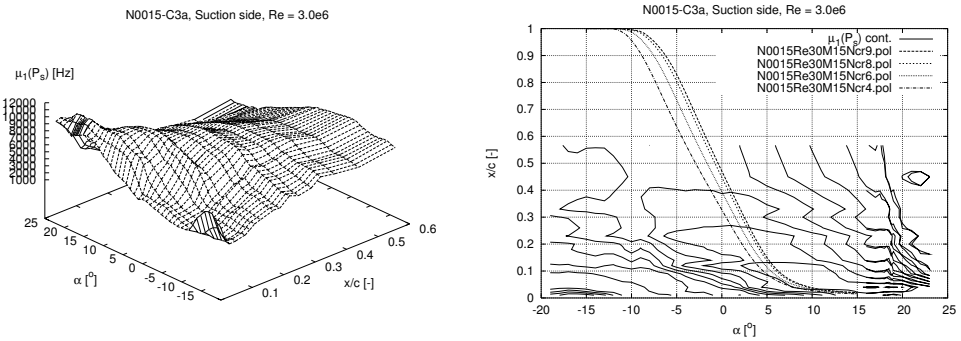

Figure 77: Fourier transform mean, $\mu_1(P_s)$

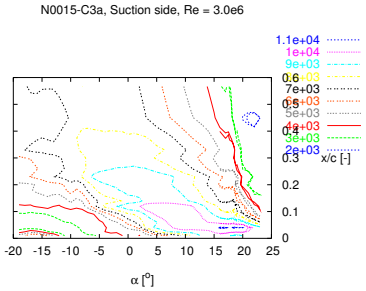

Figure 78: Contours of $\mu_1(P_s)$

```
N0015-C3a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.0100     19342.6   11097.3
 17.00  0.0100     21842.3   11097.7
 17.50  0.0100     22318.3   10928.6
 17.75  0.0100     23734.2   10926.2
 18.00  0.0100     24373.6   10870.9
 18.25  0.0100     26865.9   11011.9
 18.50  0.0100     27784.4   10940.9
 18.75  0.0100     28208.8   10931.5
 19.00  0.0100     30659.3   11097.8
 20.00  0.0100     22853.0   10891.5
 21.00  0.0100      6838.7   10013.3
 22.00  0.4939      6051.7    9895.9
 23.00  0.4883      6382.8    9936.5
 22.00  0.5079      5636.0    9899.0
 21.00  0.0100     11074.0   10352.8
 20.00  0.0100     27560.3   11017.6
 19.00  0.0100     29933.5   10888.2
 18.50  0.0100     31872.7   11177.5
 18.00  0.0100     27717.2   10967.1
```

17.50	0.0100	24519.3	10987.5
17.00	0.0100	22412.0	11044.5
16.00	0.0100	21658.6	11064.0
15.00	0.0100	20779.6	10892.3
14.00	0.0100	22150.3	10612.7
13.00	0.0100	25493.1	10592.8
12.00	0.0100	33370.6	10636.4
11.00	0.0380	44552.1	10569.3
10.00	0.0380	53352.7	10698.2
9.00	0.0380	63374.3	10721.3
8.00	0.0380	73035.2	10774.5
7.00	0.0380	72877.5	10727.4
6.00	0.0380	70076.2	10752.3
5.00	0.0380	65900.6	10699.5
4.00	0.0380	67228.2	10666.8
3.00	0.0380	68438.2	10445.2
2.00	0.0380	65199.2	9920.5
1.00	0.0520	57043.0	9872.7
0.00	0.0743	55734.5	9752.3
-1.00	0.0883	61829.6	9630.9
-2.00	0.0883	67774.9	9613.9
-3.00	0.0883	66878.8	9588.7
-4.00	0.0883	69447.1	9535.6
-5.00	0.0883	62158.2	9444.6
-6.00	0.0911	50774.6	9217.0
-7.00	0.1191	42852.5	8707.2
-8.00	0.1974	34275.2	8411.4
-9.00	0.1974	32307.7	7968.8
-10.00	0.1191	35537.9	7914.6
-11.00	0.1974	29436.2	7608.1
-12.00	0.1974	31263.9	7459.1
-13.00	0.1974	29487.7	7315.4
-14.00	0.0911	31452.0	7347.5
-15.00	0.0911	32821.8	7276.1
-16.00	0.1163	30306.4	7272.9
-17.00	0.1163	29126.3	7204.8
-18.00	0.1163	25080.0	6982.2
-19.00	0.1163	24958.6	6843.2

4.14 C6a Clean 200x200

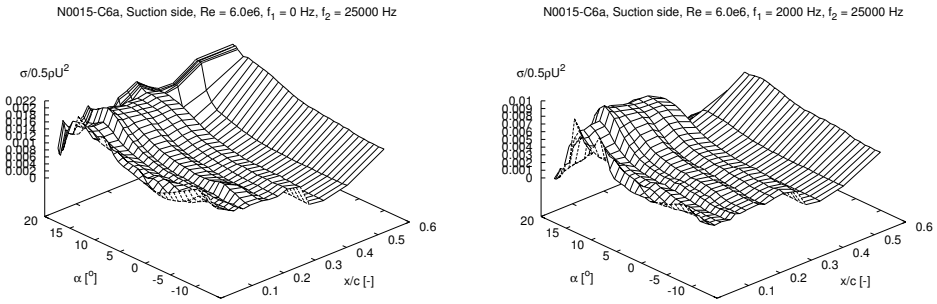

Figure 79: Pressure standard deviations, σ

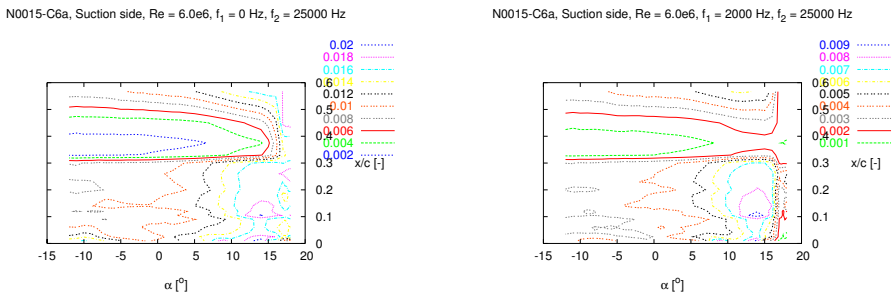

Figure 80: Contours of σ

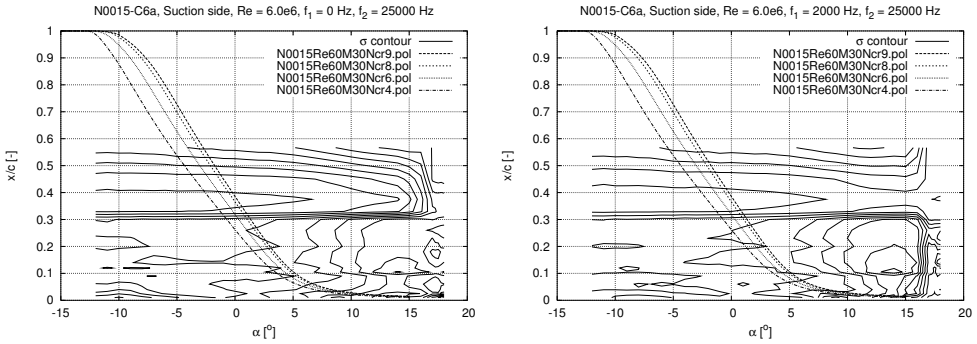

Figure 81: Contours of σ and XFoil data

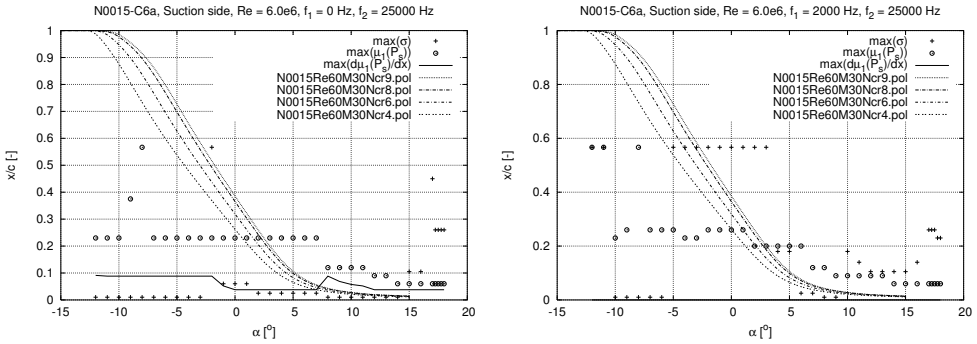

Figure 82: Transition detection

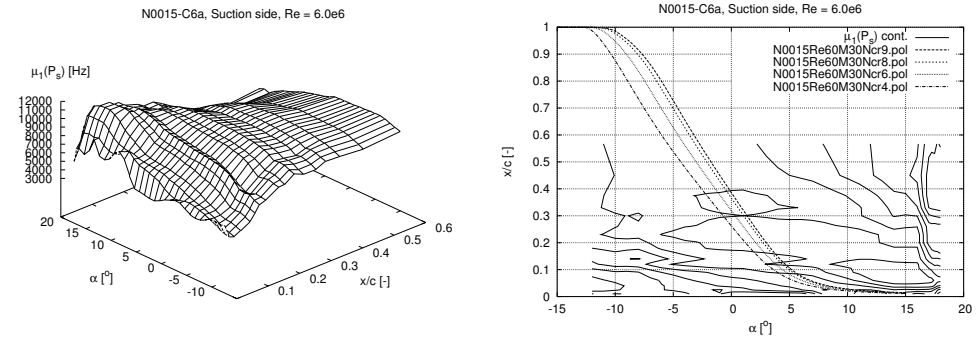

Figure 83: Fourier transform mean, $\mu_1(P_s)$

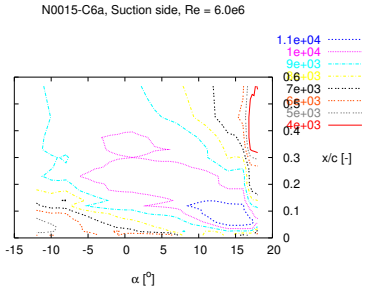

Figure 84: Contours of $\mu_1(P_s)$

```
N0015-C6a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.0911     35858.6    8830.1
-11.00  0.0883     35894.0    9050.0
-10.00  0.0883     38341.4    9329.3
 -9.00  0.0883     36974.7    9480.5
 -8.00  0.0883     34993.8    9586.5
 -7.00  0.0883     41039.2    9718.8
 -6.00  0.0883     44476.9   10026.2
 -5.00  0.0883     44666.0   10173.2
 -4.00  0.0883     41424.2   10350.5
 -3.00  0.0883     38447.4   10407.1
 -2.00  0.0883     36296.0   10514.4
 -1.00  0.0520     36985.9   10571.8
  0.00  0.0380     36394.9   10653.4
  1.00  0.0380     44612.2   10641.3
  2.00  0.0380     53003.8   10688.3
  3.00  0.0380     54463.0   10692.5
  4.00  0.0380     53907.9   10686.0
  5.00  0.0380     52719.7   10698.3
  6.00  0.0380     53283.6   10706.0
  7.00  0.0380     35665.7   10734.4
  8.00  0.0883     32945.8   10867.5
  9.00  0.0687     31924.8   11113.6
 10.00  0.0576     41084.5   11317.2
 11.00  0.0520     51382.5   11493.9
 12.00  0.0380     66919.3   11641.5
 13.00  0.0380     70897.3   11782.7
 14.00  0.0380     47211.8   11754.1
 15.00  0.0380     73814.9   11764.4
 16.00  0.0380     84052.1   11671.1
 17.00  0.0380     67248.1   11384.0
 17.25  0.0380     67776.0   11319.9
 17.50  0.0380     59732.5   10862.6
 17.75  0.0380     72029.5   10409.9
 18.00  0.0380     80089.5   10345.1
```

4.15 Z16a ZZ90 x/c=5% suc. x/c=10% press. 200x200

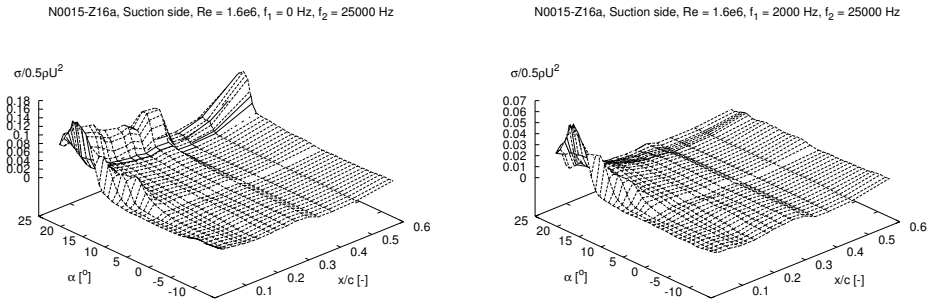

Figure 85: Pressure standard deviations, σ

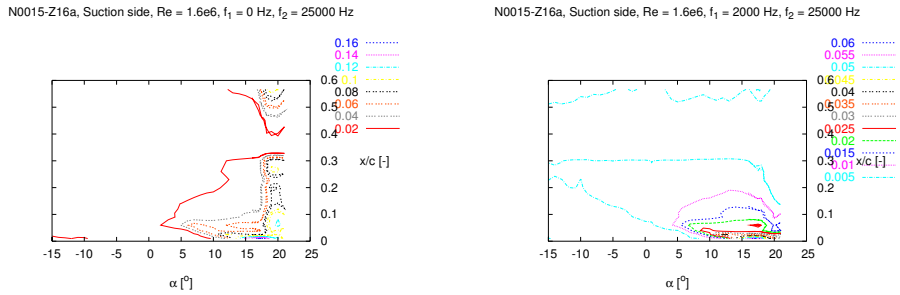

Figure 86: Contours of σ

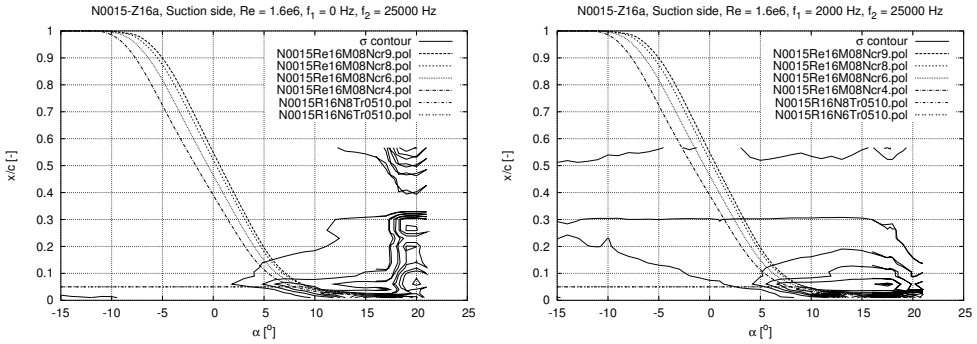

Figure 87: Contours of σ and XFoil data

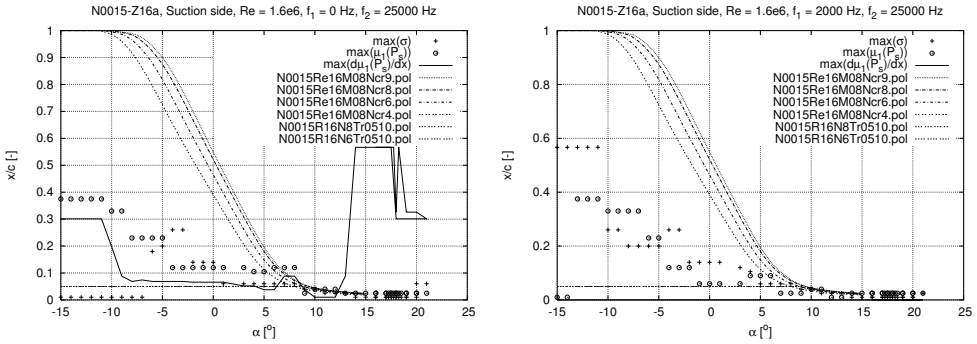

Figure 88: Transition detection

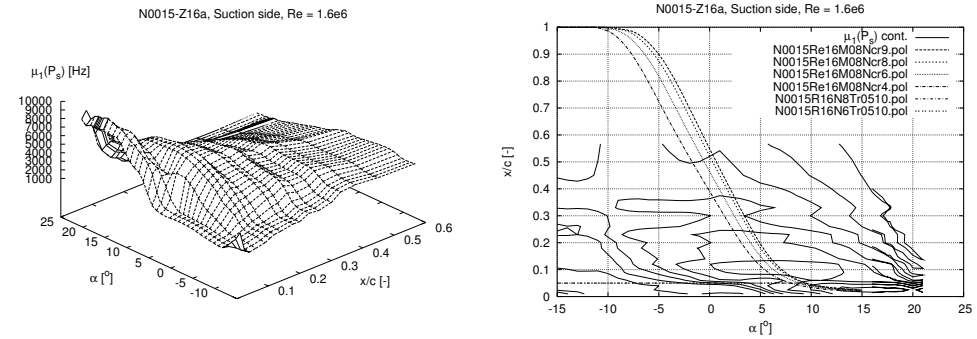

Figure 89: Fourier transform mean, $\mu_1(P_s)$

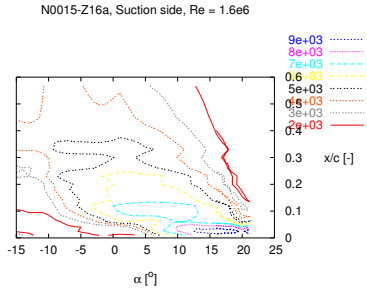

Figure 90: Contours of $\mu_1(P_s)$

```
N0015-Z16a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
16.00	0.5667	1528.8	9809.5
17.00	0.5667	1543.2	9596.0
17.25	0.5667	1515.1	9467.3
17.50	0.5667	1401.9	9441.9
17.75	0.5667	1400.7	9480.6
18.00	0.3261	1656.6	9482.7
18.25	0.5667	1283.2	9501.5
19.00	0.3261	2550.2	9281.8
20.00	0.3261	3130.5	8748.6
21.00	0.3009	2665.5	9533.4
20.00	0.3009	3788.3	8637.6
19.00	0.3009	3790.4	9333.3
18.50	0.3009	2498.1	9315.0
18.00	0.3009	2155.1	9422.6
17.50	0.5667	1374.1	9421.0
17.00	0.5667	1513.4	9606.3
16.00	0.5667	1532.4	9662.5
15.00	0.5667	1672.1	9533.0
14.00	0.5667	1856.1	9302.7
13.00	0.0883	2865.6	9174.1
12.00	0.0100	9475.0	8965.8
11.00	0.0100	16822.1	8690.5
10.00	0.0100	15807.5	8132.1
9.00	0.0380	19516.1	7527.7
8.00	0.0883	19678.6	7631.5
7.00	0.0883	31357.0	7715.5
6.00	0.0380	42079.5	7744.8
5.00	0.0380	60800.1	7732.6
4.00	0.0520	73506.3	7609.6
3.00	0.0520	80617.5	7554.2
1.00	0.0659	82245.1	7257.5
0.00	0.0659	77225.5	6977.1
-1.00	0.0659	72024.3	6688.3
-2.00	0.0659	66699.3	6414.4
-3.00	0.0687	60735.0	6108.1
-4.00	0.0687	53657.9	5738.5
-5.00	0.0687	44784.0	5587.0
-6.00	0.0687	38667.7	5546.3
-7.00	0.0743	34076.3	5412.0
-8.00	0.0687	29035.8	5237.5
-9.00	0.0883	21062.4	5102.0
-10.00	0.1974	16757.9	4716.1
-11.00	0.3009	15091.6	4460.7
-12.00	0.3009	16055.2	4295.5
-13.00	0.3009	17217.7	4274.7
-14.00	0.3009	17578.4	4278.6
-15.00	0.3009	17457.3	4229.8

4.16 Z3a ZZ90 x/c=5% suc. x/c=10% press. 200x200

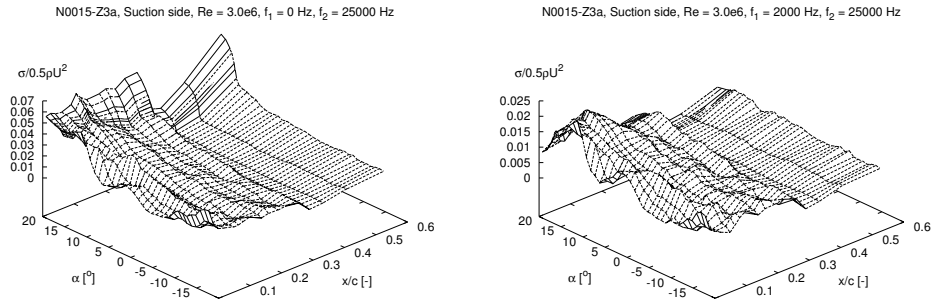

Figure 91: Pressure standard deviations, σ

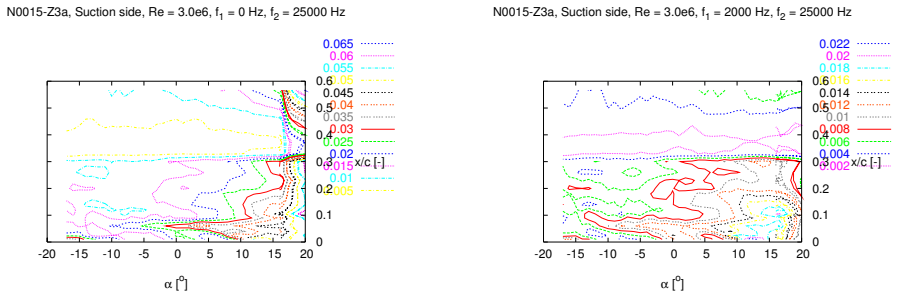

Figure 92: Contours of σ

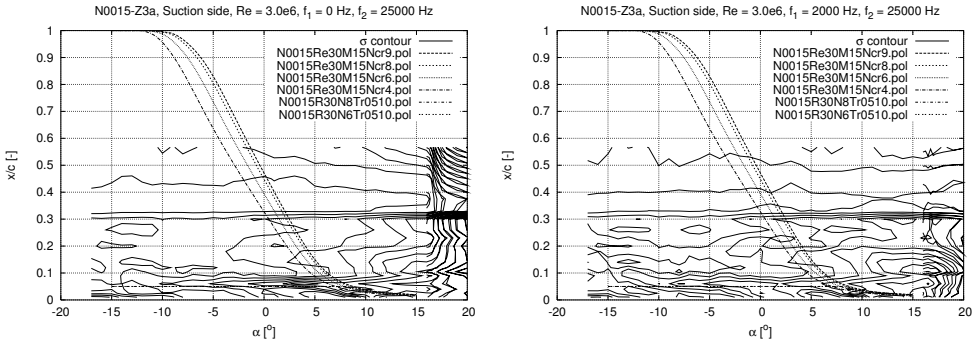

Figure 93: Contours of σ and XFoil data

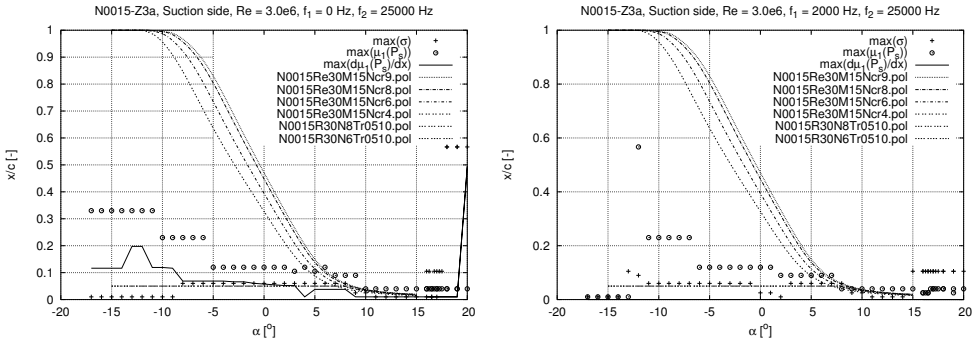

Figure 94: Transition detection

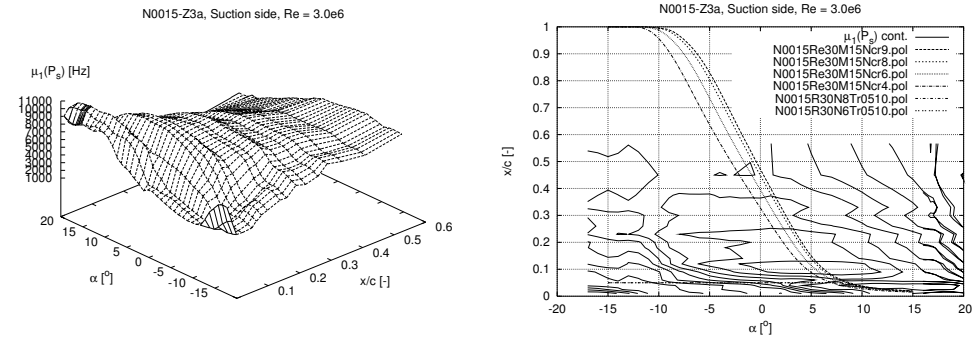

Figure 95: Fourier transform mean, $\mu_1(P_s)$

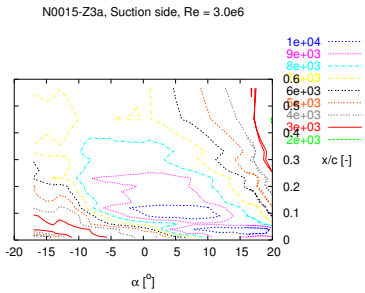

Figure 96: Contours of $\mu_1(P_s)$

```
N0015-Z3a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.0100     17520.7   10757.1
 16.25  0.0100     17924.3   10704.0
 16.50  0.0100     18871.4   10637.2
 16.75  0.0100     20647.6   10625.1
 17.00  0.0100     20737.2   10590.2
 17.25  0.0100     22480.7   10606.3
 18.00  0.0100     22967.8   10532.6
 19.00  0.0100     17533.4   10321.4
 20.00  0.4939      6701.9    9699.2
 19.00  0.0100     19989.4   10348.0
 18.00  0.0100     23902.5   10571.3
 17.50  0.0100     24003.7   10568.7
 17.00  0.0100     20567.5   10529.2
 16.50  0.0100     18924.9   10604.1
 16.00  0.0100     19192.5   10683.3
 15.00  0.0100     20450.0   10633.4
 14.00  0.0100     21121.7   10532.1
 13.00  0.0100     21695.7   10661.7
 12.00  0.0100     23525.1   10791.0
 11.00  0.0100     29640.7   10743.1
 10.00  0.0100     32372.6   10465.5
  9.00  0.0100     36862.3   10539.5
  8.00  0.0380     45495.0   10657.0
  7.00  0.0380     53166.2   10638.0
  6.00  0.0380     52689.3   10582.9
  5.00  0.0380     53353.0   10612.7
  4.00  0.0100     60885.3   10650.2
  3.00  0.0520     70485.6   10641.9
  2.00  0.0520     89512.7   10605.0
  1.00  0.0548     86857.1   10459.2
  0.00  0.0576     84173.7   10323.7
 -1.00  0.0604     87118.8   10153.7
 -2.00  0.0659     88059.8   10019.5
 -3.00  0.0659     83519.2    9741.5
 -4.00  0.0687     81211.7    9548.8
 -5.00  0.0687     78812.5    9353.8
 -6.00  0.0687     72321.9    9217.6
 -7.00  0.0687     63667.9    9086.7
 -8.00  0.0687     56945.2    8995.9
 -9.00  0.1163     40148.1    8787.7
-10.00  0.1191     39846.4    8253.0
-11.00  0.1191     31006.1    7602.7
-12.00  0.1974     30768.5    7383.5
-13.00  0.1974     31325.1    7234.4
-14.00  0.1163     25865.6    7321.8
-15.00  0.1163     30204.2    7452.4
-16.00  0.1163     29897.6    7313.9
-17.00  0.1163     27067.6    7193.1
```

4.17 Z6a ZZ90 x/c=5% suc. x/c=10% press. 200x200

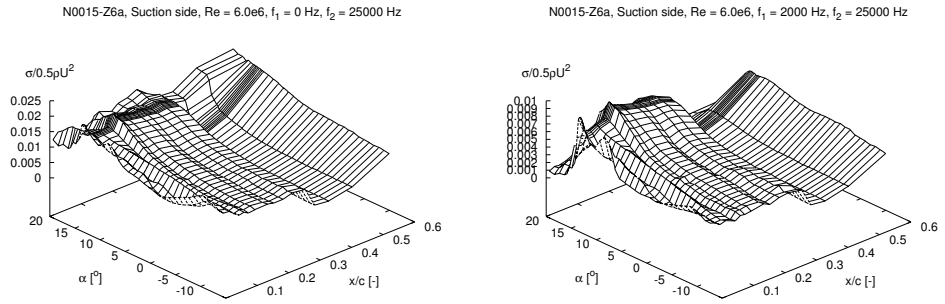

Figure 97: Pressure standard deviations, σ

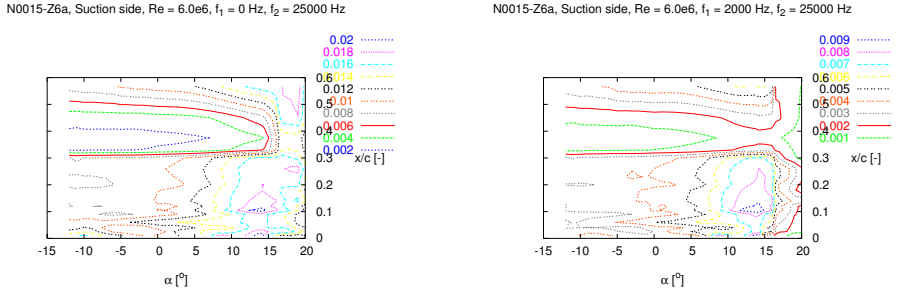

Figure 98: Contours of σ

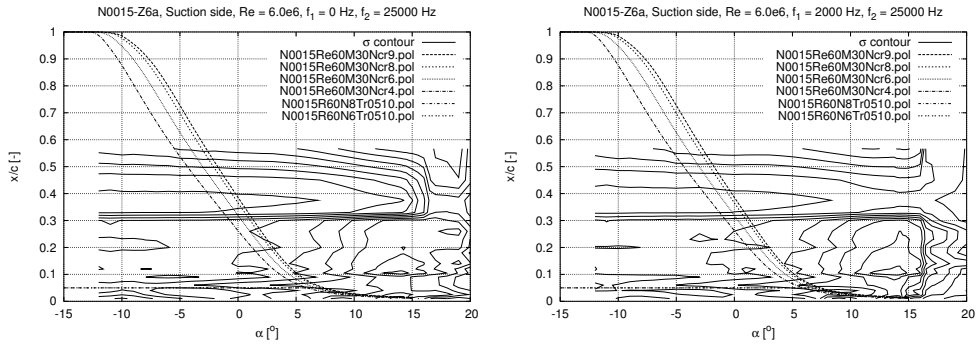

Figure 99: Contours of σ and XFoil data

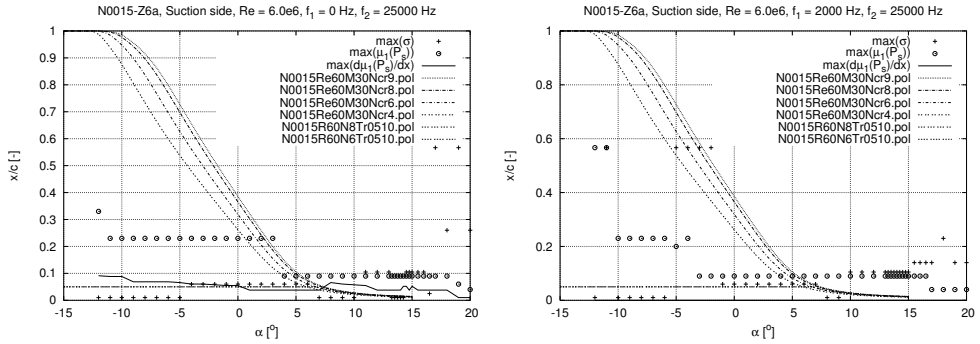

Figure 100: Transition detection

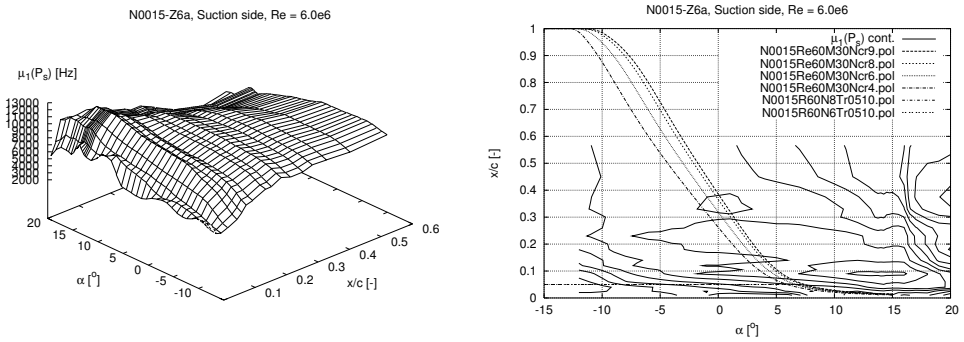

Figure 101: Fourier transform mean, $\mu_1(P_s)$

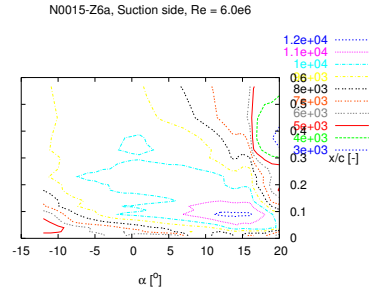

Figure 102: Contours of $\mu_1(P_s)$

```
N0015-Z6a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.0911     36165.8    8818.7
-11.00  0.0883     37752.3    9088.6
-10.00  0.0883     38220.9    9431.6
 -9.00  0.0687     40673.2    9753.9
 -8.00  0.0687     44046.9    9922.4
 -7.00  0.0687     45439.2   10056.3
 -6.00  0.0687     46932.3   10184.5
 -5.00  0.0659     47876.3   10199.1
 -4.00  0.0604     50862.8   10343.3
 -3.00  0.0604     55800.8   10345.9
 -2.00  0.0576     60705.0   10465.5
 -1.00  0.0548     63919.0   10552.6
  0.00  0.0548     60858.7   10611.4
  1.00  0.0380     62566.2   10616.5
  2.00  0.0380     70262.5   10612.8
  3.00  0.0380     72270.7   10635.1
  4.00  0.0380     73550.3   10658.8
  5.00  0.0380     74272.3   10772.0
  6.00  0.0380     74721.8   10882.8
```

7.00	0.0380	54078.6	11011.9
8.00	0.0659	41568.2	11284.3
9.00	0.0604	47682.7	11493.3
10.00	0.0576	54972.2	11743.3
11.00	0.0548	60730.8	11958.0
12.00	0.0380	68481.2	12215.0
13.00	0.0380	69226.8	12281.5
13.25	0.0380	68252.8	12273.9
13.50	0.0380	65984.9	12237.3
13.75	0.0380	60932.0	12212.0
14.00	0.0380	56229.5	12283.1
14.25	0.0520	53823.2	12241.6
14.50	0.0520	55834.1	12205.1
14.75	0.0380	58713.4	12218.1
15.00	0.0520	59700.0	12215.4
15.50	0.0380	72372.7	12192.9
16.00	0.0380	79882.3	12183.3
16.50	0.0380	71761.5	11736.5
17.00	0.0380	68043.9	11422.5
18.00	0.0380	64254.8	11020.8
19.00	0.0100	69336.7	10205.9
20.00	0.0100	80938.2	9845.1

4.18 T16a Trip wire. Bump tape 2% 200x200

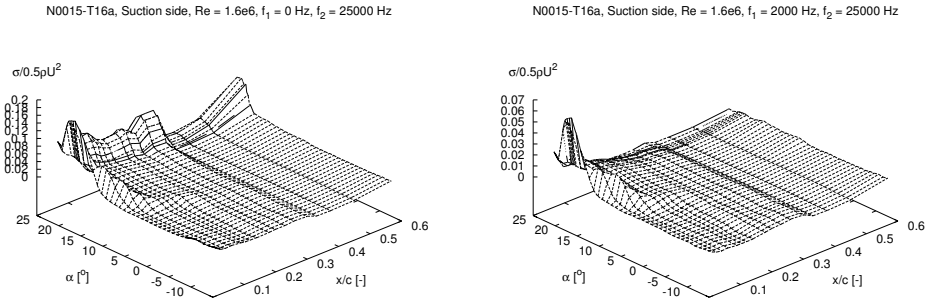

Figure 103: Pressure standard deviations, σ

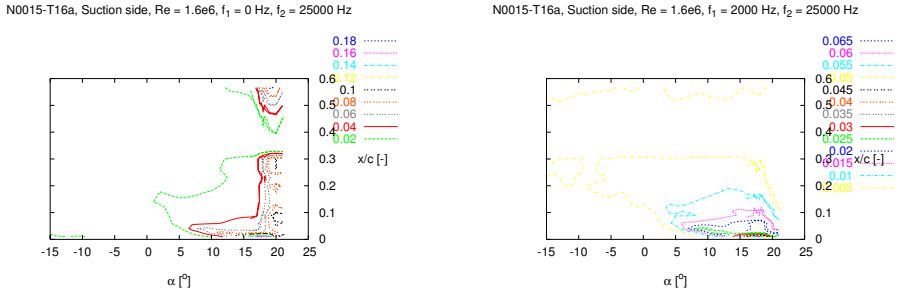

Figure 104: Contours of σ

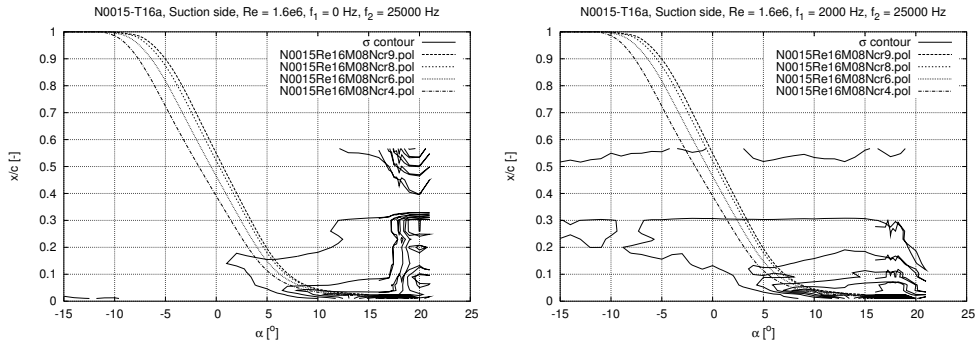

Figure 105: Contours of σ and XFoil data

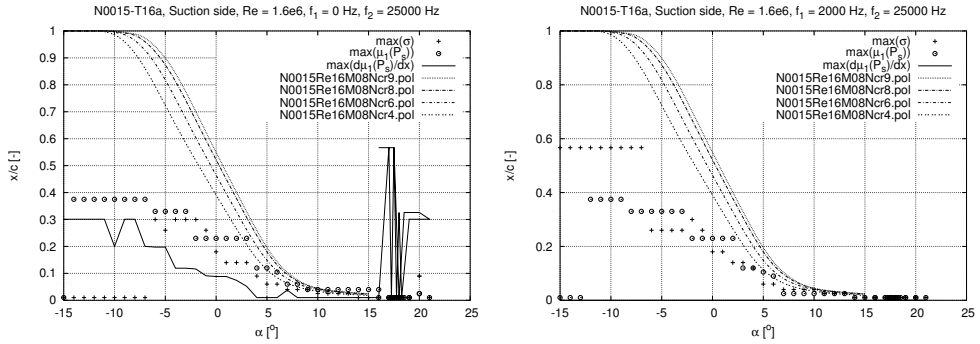

Figure 106: Transition detection

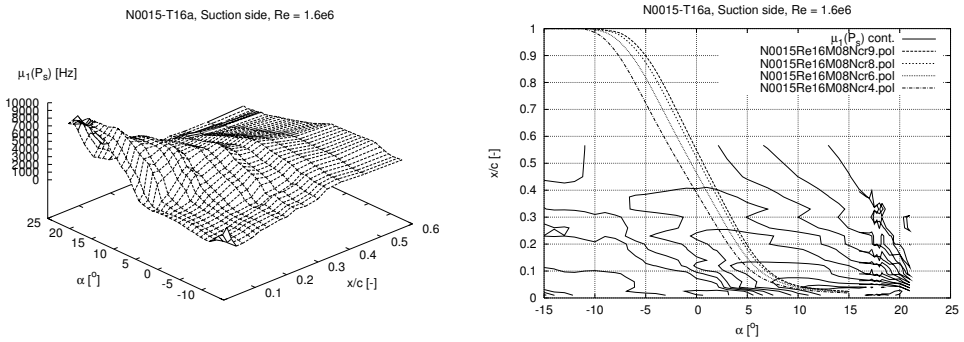

Figure 107: Fourier transform mean, $\mu_1(P_s)$

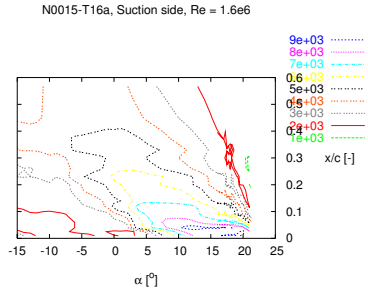

Figure 108: Contours of $\mu_1(P_s)$

```
N0015-T16a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.5667      1503.3    8972.0
 17.00  0.5667      1438.1    9014.1
 17.25  0.0100      4090.5    9085.0
 17.50  0.5667      1455.7    9001.8
 17.75  0.0100      1676.2    9142.4
 18.00  0.3261      2039.3    9011.0
 18.25  0.0100      3077.5    9203.7
 19.00  0.3009      1411.1    9132.6
 20.00  0.3009      3953.2    9238.8
 21.00  0.3009      6718.8    8182.4
 20.00  0.3261      3545.1    8399.8
 19.00  0.3261      2399.9    8985.4
 18.50  0.3261      1487.0    9071.4
 18.00  0.0100      1500.8    9043.4
 17.50  0.5667      1462.0    8959.7
 17.00  0.5667      1577.9    9060.2
 16.00  0.0100      3652.3    9072.0
 15.00  0.0100      7136.5    9053.4
 14.00  0.0100     11439.4    9095.2
```

13.00	0.0100	19211.7	9372.7
12.00	0.0100	26240.8	9454.5
11.00	0.0100	34160.6	9244.0
10.00	0.0100	37780.9	8812.5
9.00	0.0100	49507.4	8473.4
8.00	0.0100	52421.0	8200.8
7.00	0.0380	55610.1	7840.8
6.00	0.0100	68588.6	7795.6
5.00	0.0100	86534.3	7685.5
4.00	0.0100	79442.1	7384.8
3.00	0.0520	60895.6	6821.2
2.00	0.0743	45252.1	6717.1
1.00	0.0883	47917.8	6597.7
0.00	0.0883	45776.4	6276.7
-1.00	0.0911	32878.7	5809.3
-2.00	0.1163	26806.2	5542.4
-3.00	0.1191	24453.5	5416.2
-4.00	0.1191	22331.9	5308.4
-5.00	0.1974	19237.2	5219.0
-6.00	0.1974	21221.2	5102.8
-7.00	0.2002	20967.4	4967.5
-8.00	0.3009	19647.6	4806.8
-9.00	0.3009	19884.3	4641.4
-10.00	0.2002	16818.5	4566.8
-11.00	0.3009	15575.3	4392.2
-12.00	0.3009	16565.9	4274.4
-13.00	0.3009	17050.6	4264.8
-14.00	0.3009	17104.2	4258.4
-15.00	0.3009	17008.0	4280.9

4.19 T3a Trip wire. Bump tape 2% 200x200

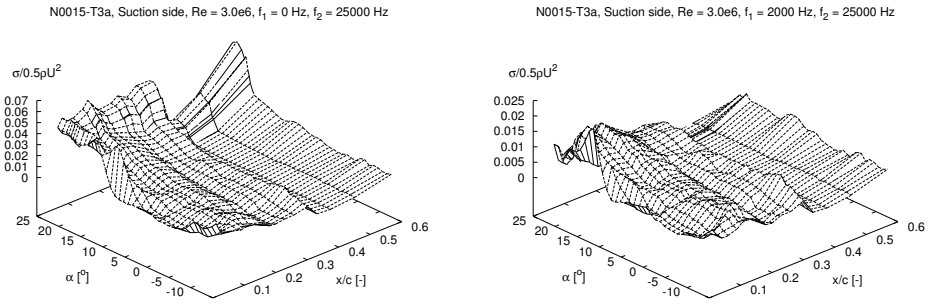

Figure 109: Pressure standard deviations, σ

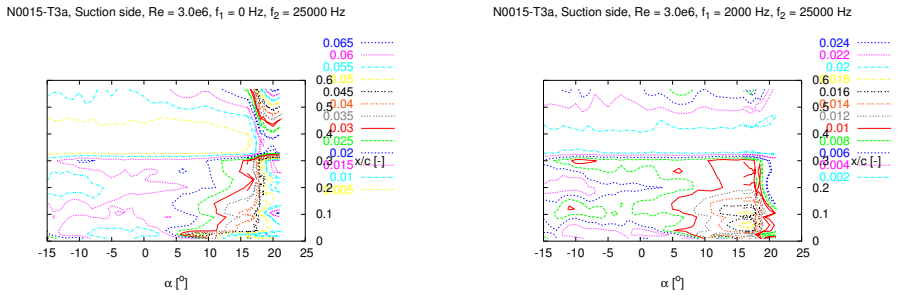

Figure 110: Contours of σ

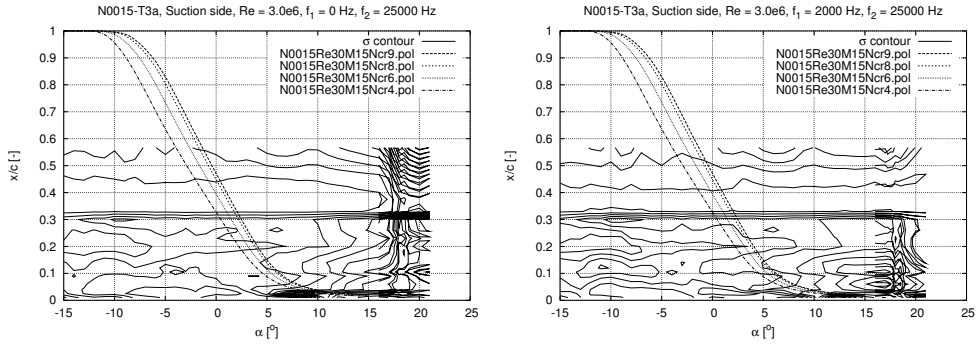

Figure 111: Contours of σ and XFoil data

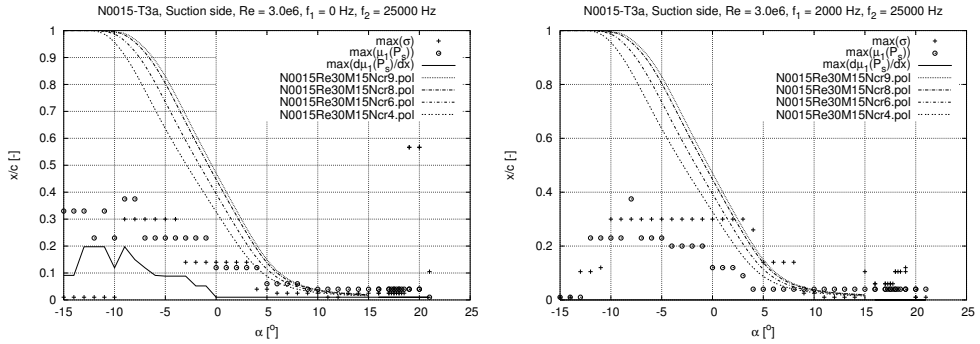

Figure 112: Transition detection

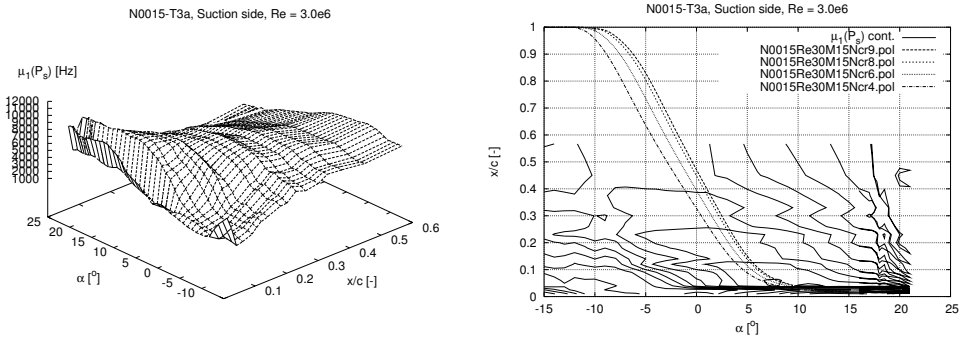

Figure 113: Fourier transform mean, $\mu_1(P_s)$

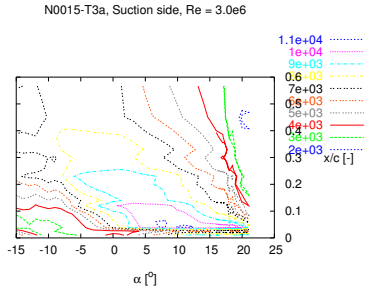

Figure 114: Contours of $\mu_1(P_s)$

```
N0015-T3a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
16.00	0.0100	76325.9	10757.9
17.00	0.0100	75623.9	10647.1
17.25	0.0100	75318.3	10532.5
17.50	0.0100	76866.1	10557.3
17.75	0.0100	81253.9	10690.2
18.00	0.0100	70088.3	10344.9
18.25	0.0100	79166.6	10587.2
19.00	0.0100	76152.9	10569.6
20.00	0.0100	66230.9	10482.3
21.00	0.0100	34559.4	9440.4
20.00	0.0100	50667.6	9692.8
19.00	0.0100	75203.2	10338.2
18.50	0.0100	87980.8	10855.1
18.00	0.0100	81789.8	10685.3
17.50	0.0100	82554.3	10717.0
17.00	0.0100	78327.2	10663.0
16.00	0.0100	81322.3	10873.1
15.00	0.0100	82374.9	10783.6
14.00	0.0100	81872.3	10710.0
13.00	0.0100	85111.1	10860.7
12.00	0.0100	89973.7	11115.2
11.00	0.0100	90558.4	11133.8
10.00	0.0100	94846.5	11028.9
9.00	0.0100	102763.9	10886.4
8.00	0.0100	121400.9	11069.2
7.00	0.0100	131001.2	11036.7
6.00	0.0100	133472.5	10936.2
5.00	0.0100	130949.6	10787.5
4.00	0.0100	127903.4	10530.8
3.00	0.0100	126080.6	10545.2
2.00	0.0100	121012.8	10282.7
1.00	0.0100	99305.5	10028.2
0.00	0.0100	82685.1	9838.0
-1.00	0.0520	70744.7	9657.6
-2.00	0.0520	61508.7	9566.4
-3.00	0.0883	56105.5	9477.5
-4.00	0.0883	61068.0	9425.8
-5.00	0.0883	58039.3	9231.1
-6.00	0.0911	46653.4	9005.7
-7.00	0.1191	39765.1	8568.2
-8.00	0.1499	33782.3	8280.9
-9.00	0.1974	32733.3	7910.9
-10.00	0.1191	34102.7	7855.7
-11.00	0.1974	31049.5	7454.6
-12.00	0.1974	33689.4	7263.2
-13.00	0.1974	28120.1	7257.0
-14.00	0.0911	30274.4	7324.7
-15.00	0.0911	30566.6	7275.0

4.20 T6a Trip wire. Bump tape 2% 200x200

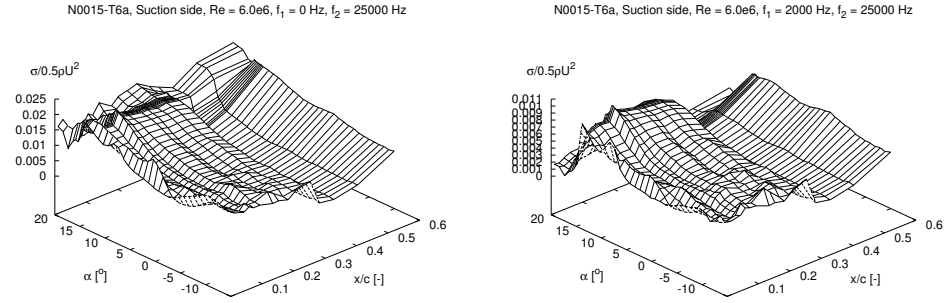

Figure 115: Pressure standard deviations, σ

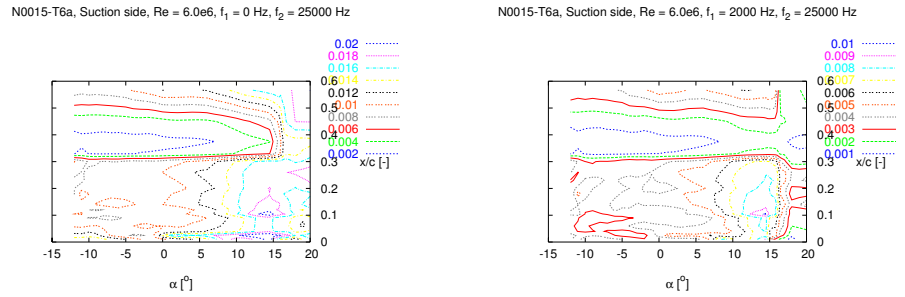

Figure 116: Contours of σ

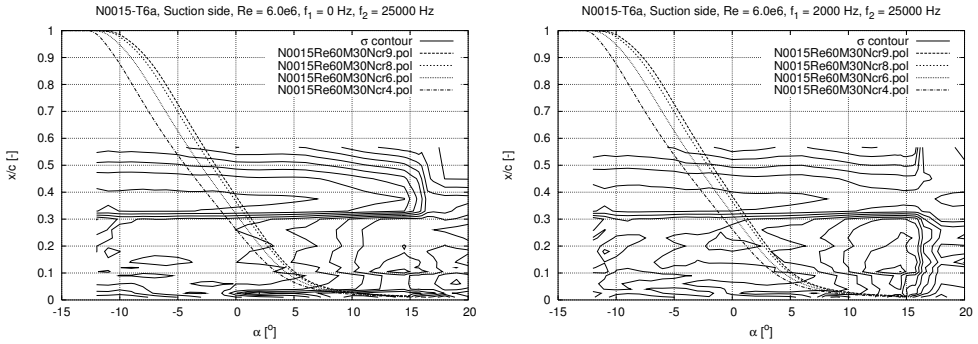

Figure 117: Contours of σ and XFoil data

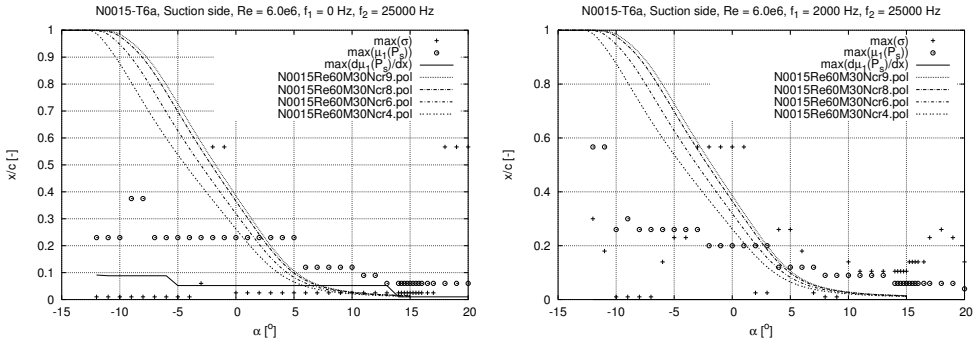

Figure 118: Transition detection

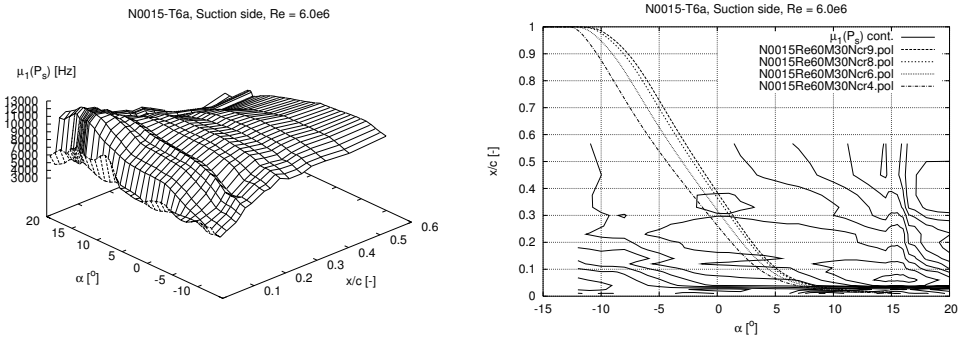

Figure 119: Fourier transform mean, $\mu_1(P_s)$

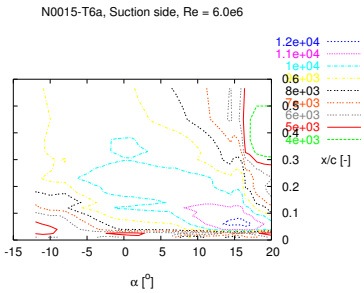

Figure 120: Contours of $\mu_1(P_s)$

N0015-T6a
alpha [degrees] angle of attack
xtr* [-] transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx* [Hz/-] d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1) [Hz] max mu1 of all chordwise positions

alpha	xtr*	d(mu1)/dx*	max(mu1)
-12.00	0.0911	33432.2	8851.5
-11.00	0.0883	34043.5	9066.0
-10.00	0.0883	37036.5	9248.2
-9.00	0.0883	35887.3	9435.9
-8.00	0.0883	33302.7	9571.2
-7.00	0.0883	39038.5	9760.9
-6.00	0.0883	40232.5	10061.2
-5.00	0.0520	38600.6	10166.8
-4.00	0.0520	47704.1	10280.3
-3.00	0.0520	55972.9	10414.3
-2.00	0.0520	66063.6	10519.8
-1.00	0.0520	74416.0	10653.2
0.00	0.0520	78528.0	10662.5
1.00	0.0520	79656.5	10701.0
2.00	0.0520	79077.0	10646.4
3.00	0.0520	73662.0	10657.4
4.00	0.0520	70958.8	10604.8
5.00	0.0520	70165.7	10578.3
6.00	0.0520	69586.6	10574.3
7.00	0.0520	68678.1	10721.9
8.00	0.0520	73246.5	10941.6
9.00	0.0520	86026.7	11163.9
10.00	0.0520	95075.1	11305.8
11.00	0.0520	100725.0	11529.5
12.00	0.0520	102878.5	11803.5
13.00	0.0520	99988.1	11917.7
14.00	0.0100	101698.0	12088.7
14.25	0.0100	101448.7	12160.3
14.50	0.0100	99889.8	12205.6
14.75	0.0100	100720.8	12146.2
15.00	0.0100	103830.0	12159.9
15.25	0.0100	105813.7	12170.3
15.50	0.0100	103397.3	12141.2
15.75	0.0100	104297.3	12184.4
16.00	0.0100	109513.0	12209.9
16.50	0.0100	121745.8	12235.3
17.00	0.0100	122651.8	12138.6
18.00	0.0100	116820.7	11445.4
19.00	0.0100	114295.0	11014.3
20.00	0.0100	122847.3	10626.3

4.21 C16b Clean 100x100

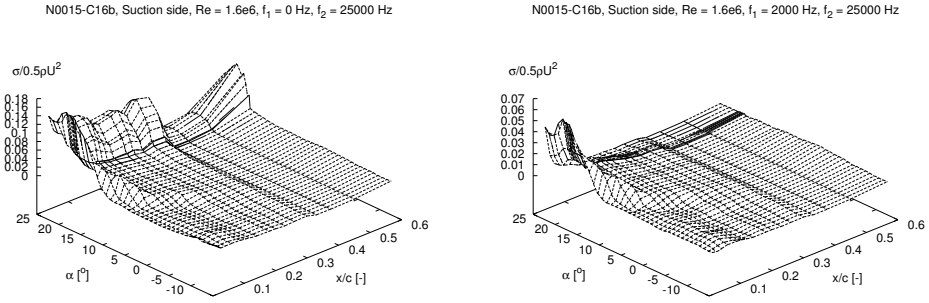

Figure 121: Pressure standard deviations, σ

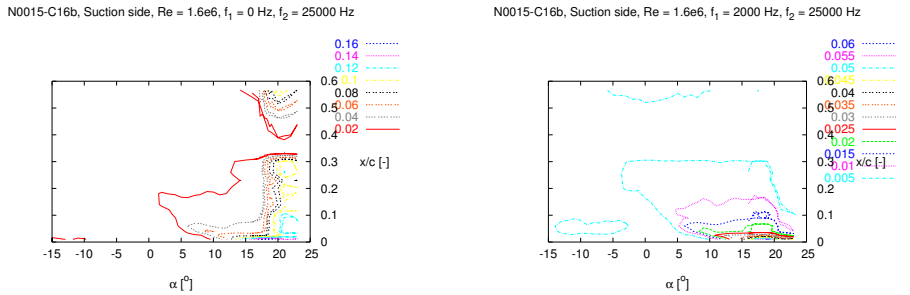

Figure 122: Contours of σ

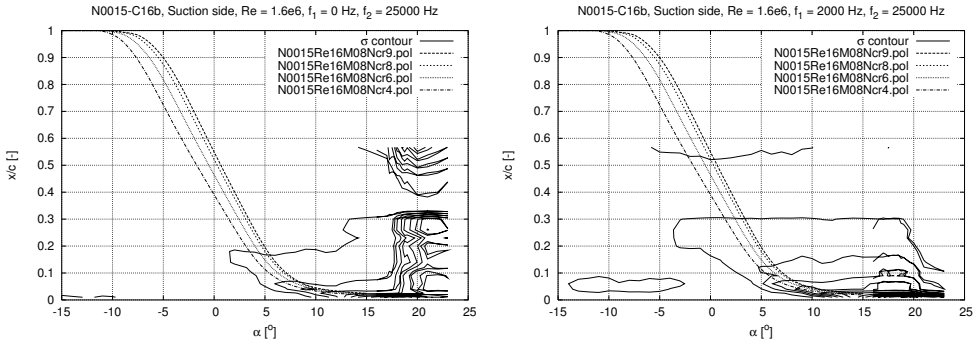

Figure 123: Contours of σ and XFoil data

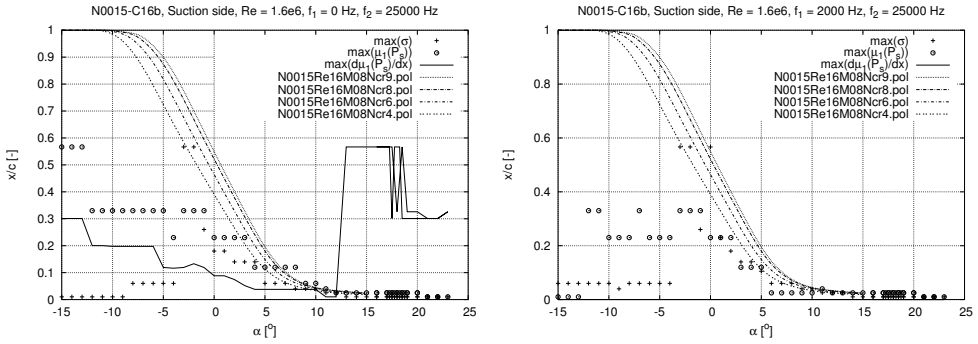

Figure 124: Transition detection

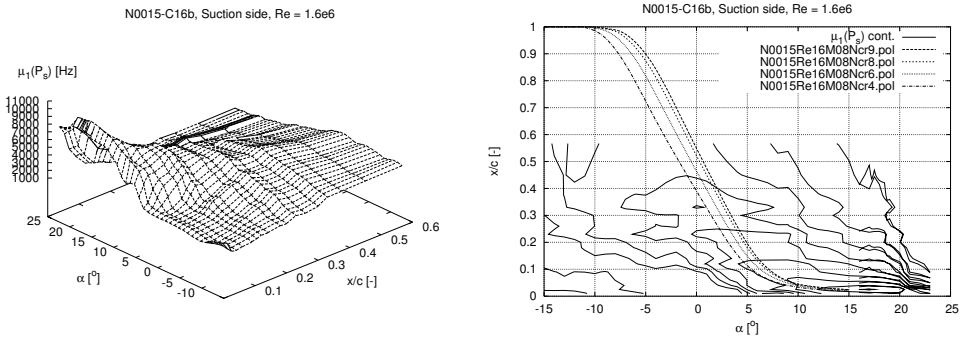

Figure 125: Fourier transform mean, $\mu_1(P_s)$

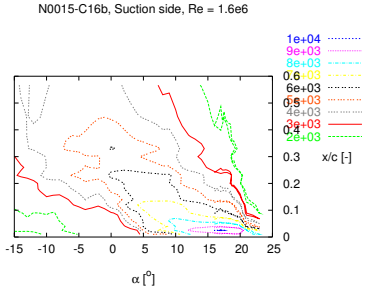

Figure 126: Contours of $\mu_1(P_s)$

```
N0015-C16b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.5667      1647.9    9847.9
 17.00  0.5667      1815.0   10104.8
 17.25  0.5667      1642.8    9984.5
 17.50  0.3009      1923.2    9895.8
 17.75  0.5667      1737.7    9953.9
 18.00  0.5667      1642.1    9942.6
 18.25  0.5667      1655.4    9929.1
 18.50  0.3009      2516.3    9920.1
 18.75  0.3009      2341.8    9830.3
 19.00  0.3009      1630.9    9901.1
 20.00  0.3009      3308.5    9787.0
 21.00  0.3009      3991.2    8299.5
 22.00  0.3009      4042.7    8035.2
 23.00  0.3261      3536.4    8021.0
 22.00  0.3009      3569.1    8161.5
 21.00  0.3009      4370.3    8326.0
 20.00  0.3261      2300.6    9667.3
 19.00  0.3261      1612.0    9822.3
 18.50  0.5667      1485.3    9846.7
 18.00  0.3261      1708.7    9861.1
 17.50  0.5667      1771.9   10033.3
 17.00  0.5667      1692.0   10069.0
 16.00  0.5667      1676.1   10003.4
 15.00  0.5667      1881.5    9777.5
 14.00  0.5667      2028.3    9560.1
 13.00  0.5667      2125.3    9345.6
 12.00  0.0100      4656.1    9031.4
 11.00  0.0100     14469.2    8639.6
 10.00  0.0380     24976.0    8217.4
  9.00  0.0380     46417.7    8051.1
  8.00  0.0380     47522.9    7776.3
  7.00  0.0380     37150.2    7727.8
  6.00  0.0380     29219.7    7705.4
  5.00  0.0380     43213.0    7494.2
  4.00  0.0380     52179.9    6930.8
  3.00  0.0520     47438.0    6557.2
  2.00  0.0743     40728.5    6546.2
  1.00  0.0883     43309.3    6377.7
  0.00  0.0883     38772.4    6244.7
 -1.00  0.1191     27692.4    5887.6
 -2.00  0.1331     22761.5    5618.5
 -3.00  0.1191     25003.0    5588.9
 -4.00  0.1163     27718.7    5554.2
 -5.00  0.1191     21735.0    5246.7
 -6.00  0.1974     20202.7    5194.1
 -7.00  0.1974     21421.6    5119.4
 -8.00  0.1974     21182.7    4842.9
 -9.00  0.1974     20321.7    4772.0
-10.00  0.1974     17558.0    4658.2
-11.00  0.2002     15768.8    4359.2
-12.00  0.2002     13094.6    4121.3
-13.00  0.3009     13912.1    4053.4
-14.00  0.3009     14609.2    4041.4
-15.00  0.3009     14439.2    3864.6
```

4.22 C3b Clean 100x100

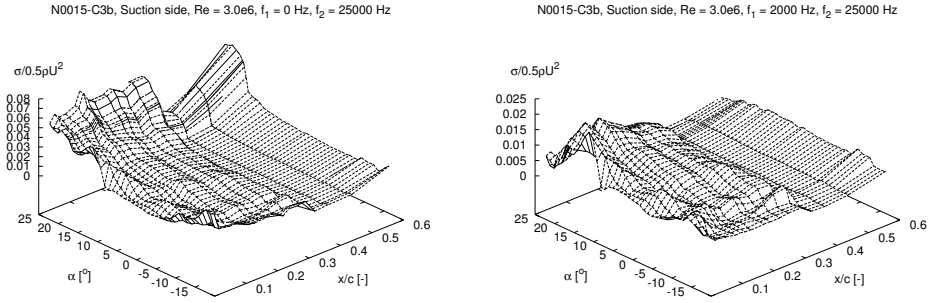

Figure 127: Pressure standard deviations, σ

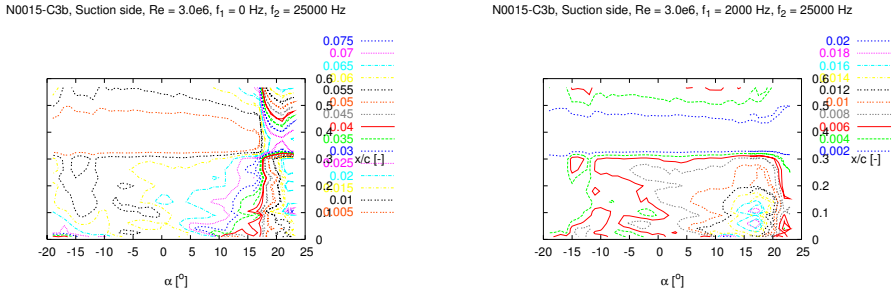

Figure 128: Contours of σ

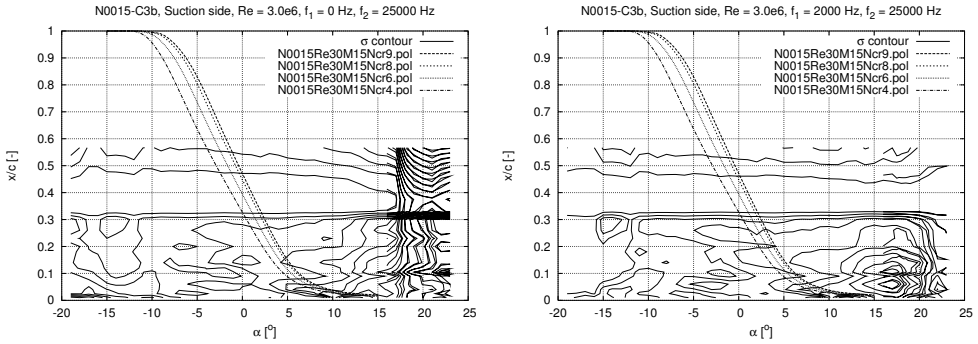

Figure 129: Contours of σ and XFoil data

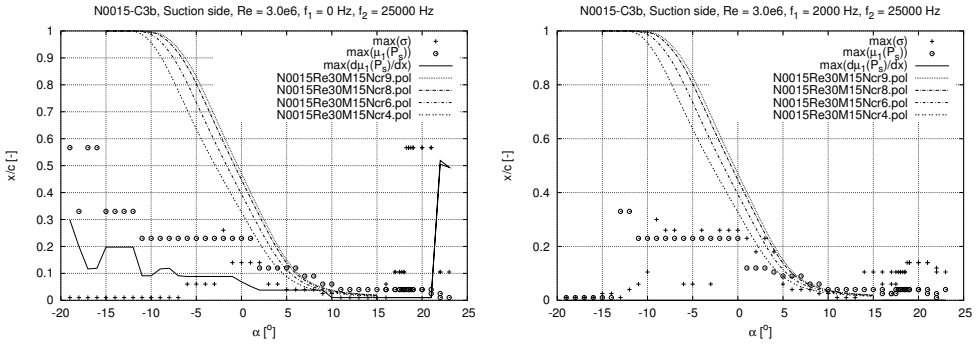

Figure 130: Transition detection

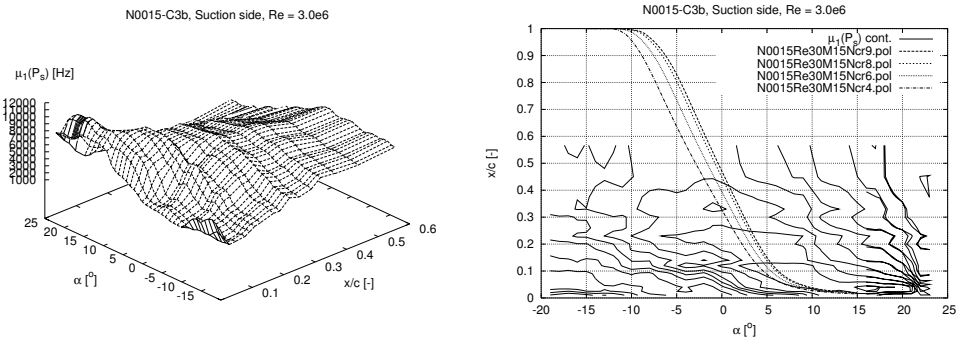

Figure 131: Fourier transform mean, $\mu_1(P_s)$

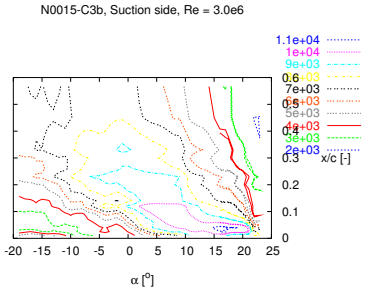

Figure 132: Contours of $\mu_1(P_s)$

```
N0015-C3b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.0100     15981.9   11300.6
 17.00  0.0100     17586.7   11292.9
 17.50  0.0100     20612.7   11020.0
 17.75  0.0100     23576.3   11013.5
 18.00  0.0100     26151.7   10965.7
 18.25  0.0100     28570.8   11019.9
 18.50  0.0100     29803.5   11018.8
 18.75  0.0100     29382.3   11051.8
 19.00  0.0100     29008.8   11019.4
 20.00  0.0100     26272.3   10898.1
 21.00  0.0100      6992.8    9929.3
 22.00  0.5191      5650.6    8391.5
 23.00  0.4939      6051.8    8069.4
 22.00  0.5051      5792.2    8064.5
 21.00  0.0100     21365.0   10434.4
 20.00  0.0100     27350.9   10830.8
 19.00  0.0100     30372.6   10945.9
 18.50  0.0100     30244.6   10975.6
 18.00  0.0100     26398.4   10833.8
```

17.50	0.0100	23646.8	10964.4
17.00	0.0100	20654.0	11176.2
16.00	0.0100	20899.1	11334.0
15.00	0.0100	19767.4	11119.0
14.00	0.0100	19581.0	10676.2
13.00	0.0100	19537.0	10505.3
12.00	0.0100	20806.0	10708.7
11.00	0.0100	27816.2	10837.3
10.00	0.0100	33346.4	10672.8
9.00	0.0380	57844.9	10773.3
8.00	0.0380	69511.6	10754.5
7.00	0.0380	70675.4	10619.3
6.00	0.0380	67730.9	10584.1
5.00	0.0380	65215.9	10625.6
4.00	0.0380	63476.9	10564.3
3.00	0.0380	62257.8	10382.8
2.00	0.0380	64160.9	10052.9
1.00	0.0520	59454.5	9799.2
0.00	0.0687	58933.1	9856.5
-1.00	0.0883	66893.7	9692.9
-2.00	0.0883	66166.6	9407.1
-3.00	0.0883	67097.5	9442.5
-4.00	0.0883	64394.7	9281.8
-5.00	0.0883	60139.7	9113.2
-6.00	0.0883	53248.1	9076.2
-7.00	0.0911	48518.7	8967.0
-8.00	0.1191	43322.6	8611.9
-9.00	0.1163	43079.9	8350.0
-10.00	0.0911	39409.2	8017.9
-11.00	0.0911	32495.9	7539.6
-12.00	0.1974	31045.6	7582.4
-13.00	0.1974	33390.9	7469.5
-14.00	0.1974	31967.8	7281.8
-15.00	0.1974	25596.0	7007.2
-16.00	0.1191	26460.8	7174.8
-17.00	0.1163	25993.0	7134.8
-18.00	0.2002	24667.7	6881.7
-19.00	0.2981	23776.8	6828.2

4.23 C6b Clean 100x100

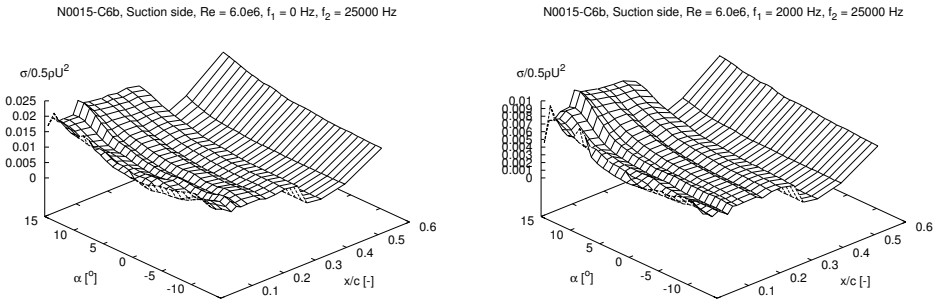

Figure 133: Pressure standard deviations, σ

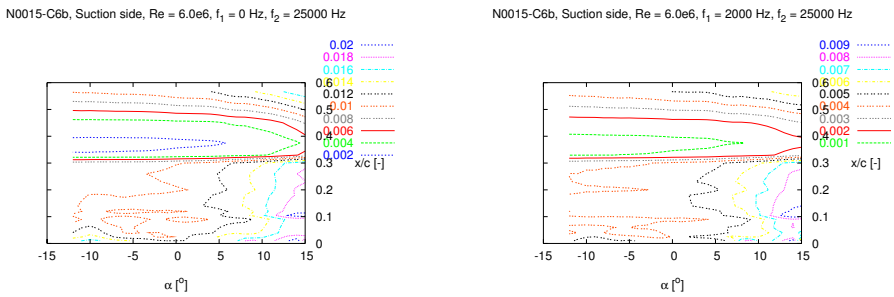

Figure 134: Contours of σ

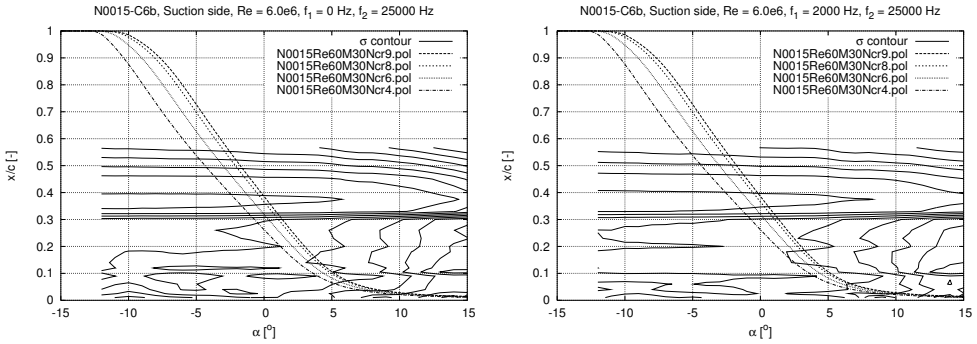

Figure 135: Contours of σ and XFoil data

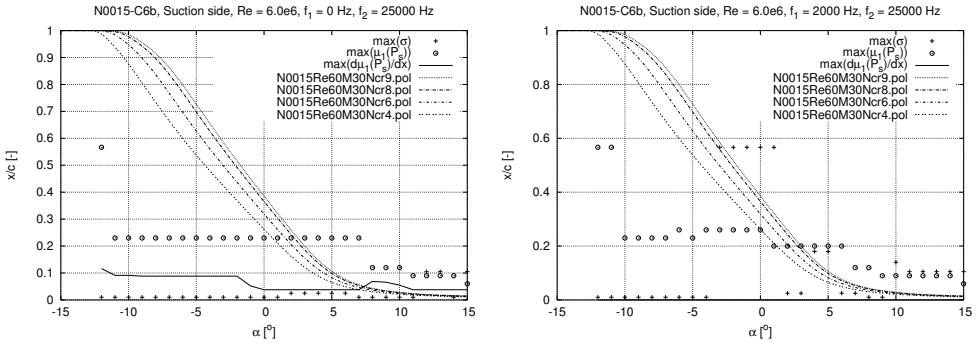

Figure 136: Transition detection

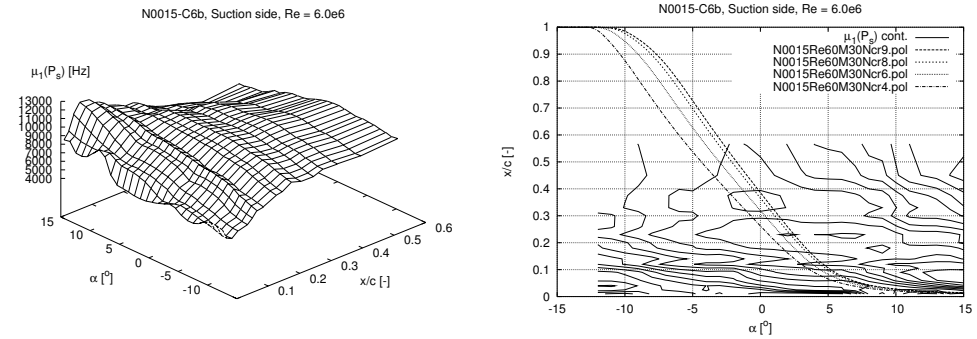

Figure 137: Fourier transform mean, $\mu_1(P_s)$

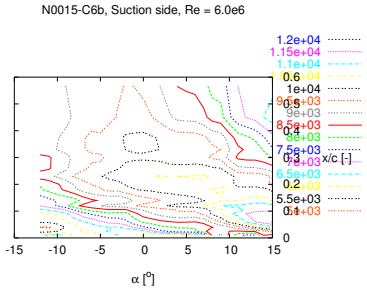

Figure 138: Contours of $\mu_1(P_s)$

```
N0015-C6b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.1163     24709.0     8835.3
-11.00  0.0911     28335.5     8827.7
-10.00  0.0911     30016.4     9084.3
 -9.00  0.0883     31428.6     9284.2
 -8.00  0.0883     33978.9     9563.6
 -7.00  0.0883     35833.5     9743.8
 -6.00  0.0883     36675.6     9911.1
 -5.00  0.0883     34322.1     9956.3
 -4.00  0.0883     33114.9    10136.6
 -3.00  0.0883     32906.0    10232.1
 -2.00  0.0883     30672.4    10388.3
 -1.00  0.0520     36813.0    10453.2
  0.00  0.0380     41703.1    10489.1
  1.00  0.0380     47434.2    10476.1
  2.00  0.0380     51320.9    10535.2
  3.00  0.0380     52743.9    10483.9
  4.00  0.0380     51925.2    10500.2
  5.00  0.0380     50261.8    10502.2
  6.00  0.0380     48203.4    10551.8
  7.00  0.0380     36657.6    10541.0
  8.00  0.0687     27037.3    10703.7
  9.00  0.0659     30217.5    10926.1
 10.00  0.0548     38235.5    11089.5
 11.00  0.0380     52125.2    11152.1
 12.00  0.0380     64922.4    11501.4
 13.00  0.0380     69965.8    11735.2
 14.00  0.0380     56390.0    11862.2
 15.00  0.0380     61441.0    12002.6
```

4.24 Z16b ZZ90 x/c=5% suc. x/c=10% press. 100x100

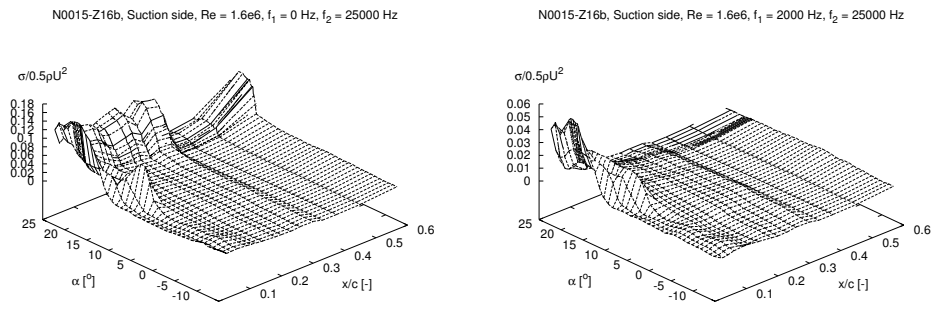

Figure 139: Pressure standard deviations, σ

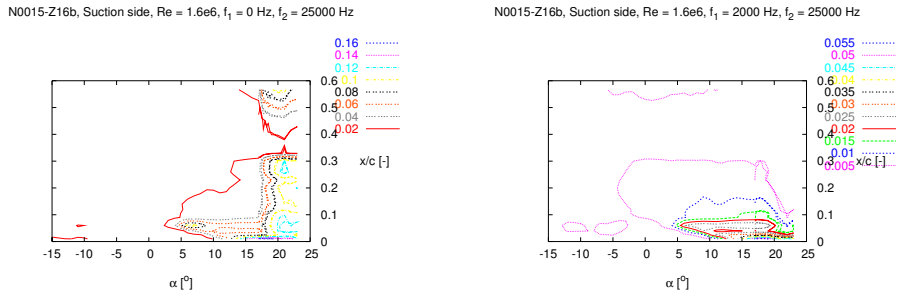

Figure 140: Contours of σ

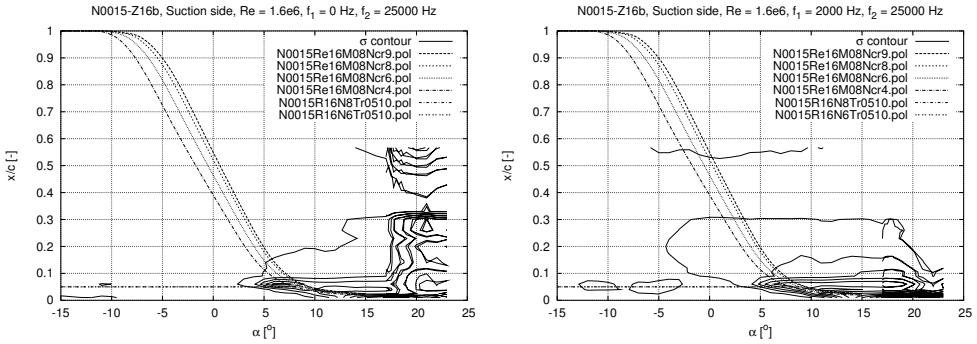

Figure 141: Contours of σ and XFoil data

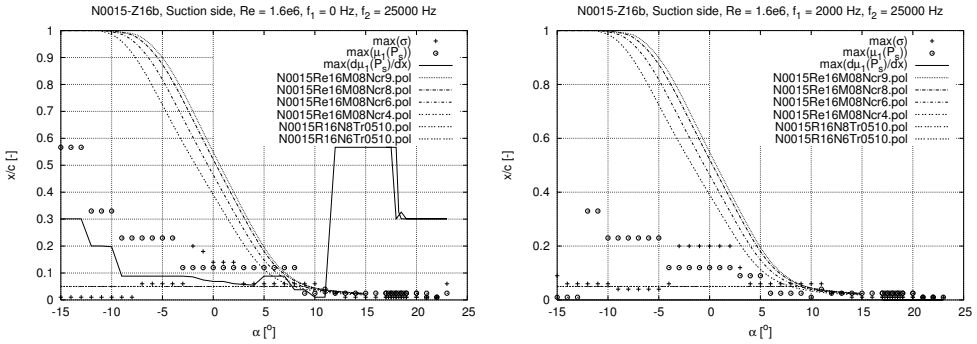

Figure 142: Transition detection

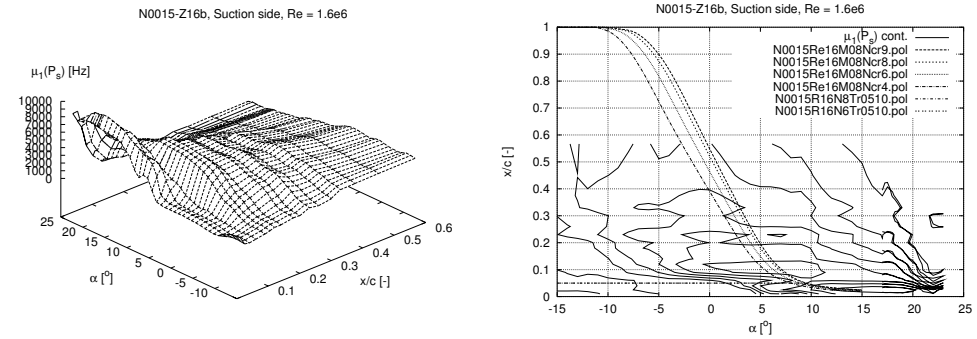

Figure 143: Fourier transform mean, $\mu_1(P_s)$

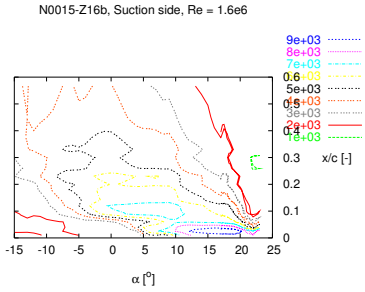

Figure 144: Contours of $\mu_1(P_s)$

N0015-Z16b
alpha [degrees] angle of attack
xtr* [-] transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx* [Hz/-] d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1) [Hz] max mu1 of all chordwise positions

alpha	xtr*	d(mu1)/dx*	max(mu1)
17.00	0.5667	1567.7	9577.8
17.25	0.5667	1712.7	9874.1
17.50	0.5667	1655.4	9863.9
17.75	0.5667	1588.5	9742.0
18.00	0.5667	1577.8	9716.1
18.25	0.3261	2568.8	9767.9
18.50	0.3009	1850.9	9750.6
18.75	0.3009	2139.9	9711.2
19.00	0.3009	2299.9	9704.4
20.00	0.3009	2337.3	9269.8
21.00	0.3009	4905.1	8282.9
22.00	0.3009	4040.0	8121.5
23.00	0.3009	3522.8	8840.4
22.00	0.3009	4249.2	8103.7
21.00	0.3009	4538.9	8711.2
20.00	0.3009	3639.2	9127.2
19.00	0.3009	2249.3	9744.3
18.50	0.3261	2162.0	9749.7
18.00	0.3009	1695.1	9779.8
17.50	0.5667	1616.9	9771.4
17.00	0.5667	1692.3	9929.8
16.00	0.5667	1696.5	9907.2
15.00	0.5667	1857.2	9730.3
14.00	0.5667	1958.3	9505.7
13.00	0.5667	2053.4	9275.5
12.00	0.5667	2109.6	8985.9
11.00	0.0100	11878.0	8533.8
10.00	0.0100	9867.1	8007.3
9.00	0.0380	30629.5	7687.2
8.00	0.0380	33440.3	7604.7
7.00	0.0883	36020.4	7567.2
6.00	0.0883	43482.4	7579.9
5.00	0.0883	49427.1	7556.5
4.00	0.0548	63219.0	7476.2
3.00	0.0576	69998.1	7358.5
2.00	0.0604	75700.2	7233.9
1.00	0.0687	78506.0	7195.7
0.00	0.0687	76227.6	7096.9
-1.00	0.0743	73366.8	6931.8
-2.00	0.0855	70673.6	6616.7
-3.00	0.0883	62922.2	6168.9
-4.00	0.0883	51258.4	5685.6
-5.00	0.0883	44548.6	5563.3
-6.00	0.0883	39620.3	5511.2
-7.00	0.0883	34285.5	5441.6
-8.00	0.0883	28398.1	5184.2
-9.00	0.0883	21793.7	4816.7
-10.00	0.1974	16714.1	4548.0
-11.00	0.2002	16886.0	4353.9
-12.00	0.2002	13329.0	4103.3
-13.00	0.3009	13596.7	4033.4
-14.00	0.3009	14018.6	3987.3
-15.00	0.3009	14512.4	3887.2

4.25 Z3b ZZ90 x/c=5% suc. x/c=10% press. 100x100

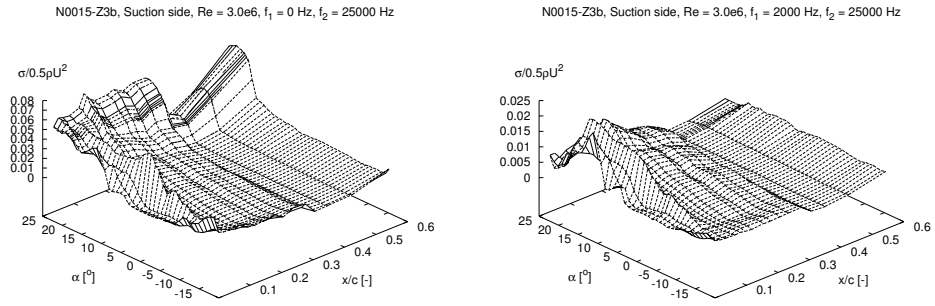

Figure 145: Pressure standard deviations, σ

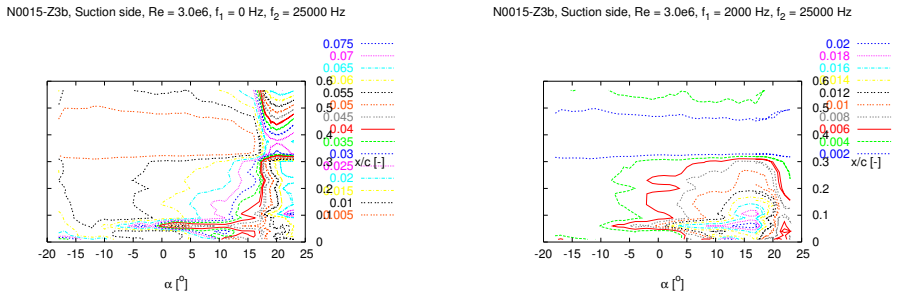

Figure 146: Contours of σ

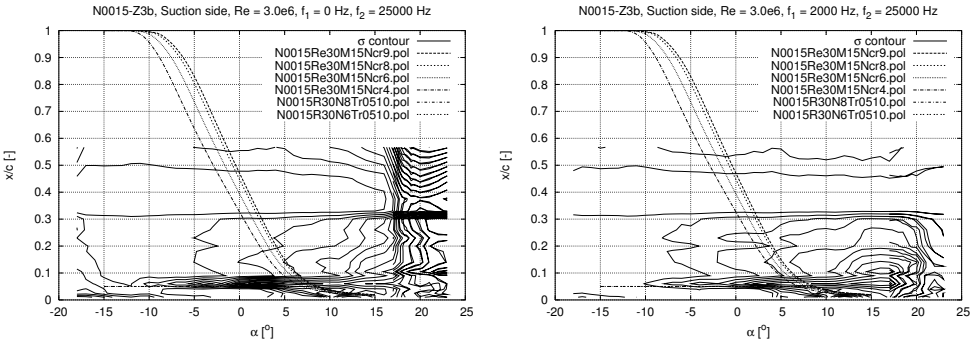

Figure 147: Contours of σ and XFoil data

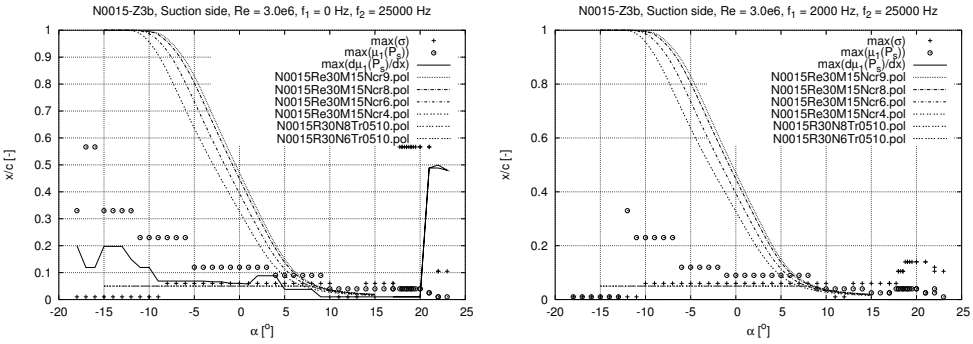

Figure 148: Transition detection

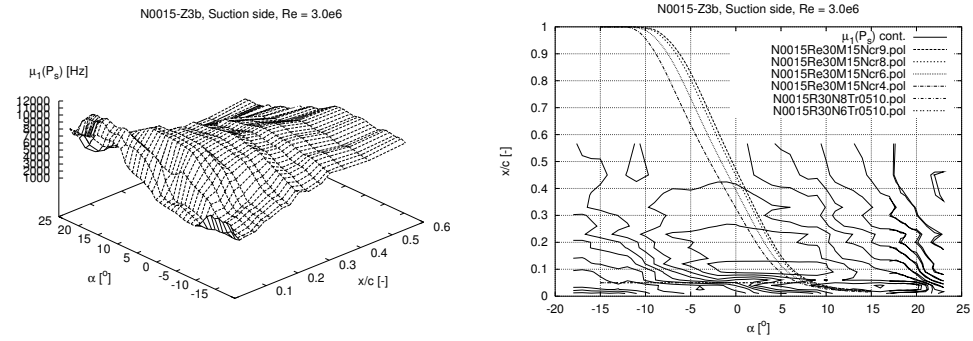

Figure 149: Fourier transform mean, $\mu_1(P_s)$

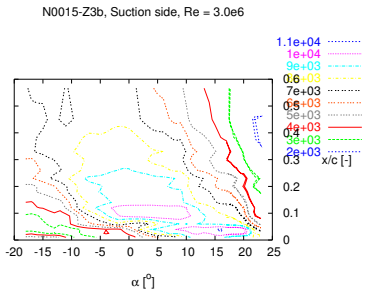

Figure 150: Contours of $\mu_1(P_s)$

```
N0015-Z3b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 17.00  0.0100     13799.7   10832.6
 17.75  0.0100     19375.8   10725.1
 18.00  0.0100     23828.5   10856.2
 18.25  0.0100     23755.4   10796.1
 18.50  0.0100     24397.7   10849.7
 18.75  0.0100     26144.7   10880.1
 19.00  0.0100     24801.8   10763.1
 19.25  0.0100     23597.5   10770.3
 20.00  0.0100     17772.1   10361.2
 21.00  0.4883      4084.9    9220.4
 22.00  0.4883      5543.1    8353.6
 23.00  0.4799      5253.7    8387.1
 22.00  0.4995      5563.7    7758.4
 21.00  0.4883      5046.9    9685.6
 20.00  0.0100     22248.0   10597.9
 19.50  0.0100     24775.9   10790.6
 19.00  0.0100     24332.5   10823.0
 18.50  0.0100     26136.7   10943.0
 18.00  0.0100     25336.7   10842.0
 17.00  0.0100     17471.8   10730.0
 16.00  0.0100     17357.5   11154.6
 15.00  0.0100     17284.1   10901.5
 14.00  0.0100     18531.9   10578.2
 13.00  0.0100     17662.1   10523.5
 12.00  0.0100     19472.3   10811.4
 11.00  0.0100     26949.9   10939.8
 10.00  0.0100     31563.7   10531.8
  9.00  0.0100     38364.6   10707.0
  8.00  0.0380     47453.7   10750.4
  7.00  0.0380     50916.2   10681.3
  6.00  0.0380     51694.6   10661.5
  5.00  0.0380     48095.1   10646.2
  4.00  0.0883     56850.7   10648.9
  3.00  0.0883     65243.3   10628.9
  2.00  0.0883     69832.7   10591.5
  1.00  0.0576     90702.9   10576.4
  0.00  0.0604     97379.9   10554.9
 -1.00  0.0604    105243.3   10508.8
 -2.00  0.0659    105875.3   10338.4
 -3.00  0.0659     98155.1   10037.6
 -4.00  0.0687     85719.9    9680.8
 -5.00  0.0687     79217.6    9307.4
 -6.00  0.0687     71443.6    9216.3
 -7.00  0.0687     66148.2    9168.1
 -8.00  0.0687     58399.6    8935.4
 -9.00  0.0687     45474.5    8552.8
-10.00  0.1191     39912.3    8194.3
-11.00  0.1191     35662.0    7833.3
-12.00  0.1499     29706.4    7759.8
-13.00  0.1974     30093.6    7771.2
-14.00  0.1974     28938.9    7593.7
-15.00  0.1974     25967.2    7323.6
-16.00  0.1191     24484.2    7207.4
-17.00  0.1191     23386.4    7209.1
-18.00  0.2002     24537.1    6914.5
```

4.26 Z6b ZZ90 x/c=5% suc. x/c=10% press. 100x100

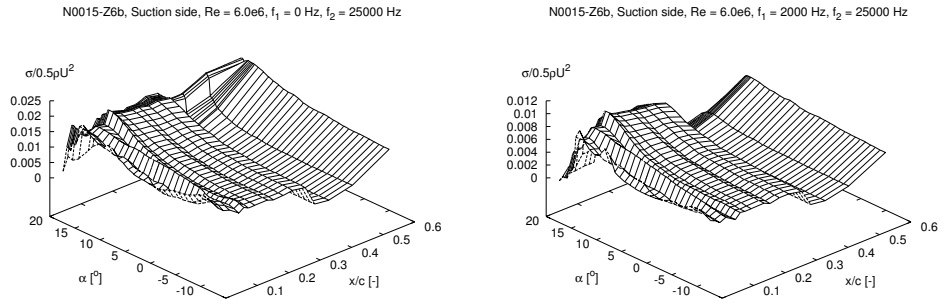

Figure 151: Pressure standard deviations, σ

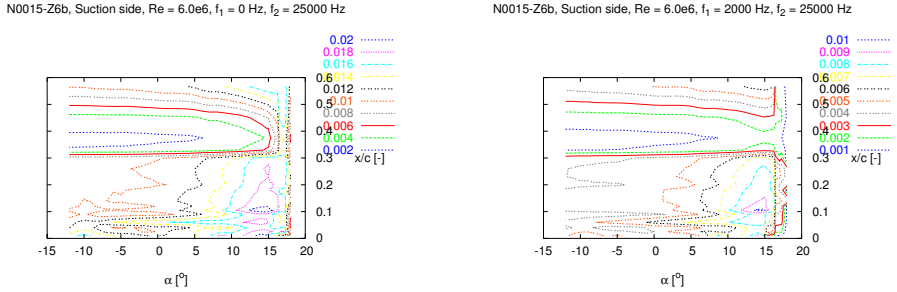

Figure 152: Contours of σ

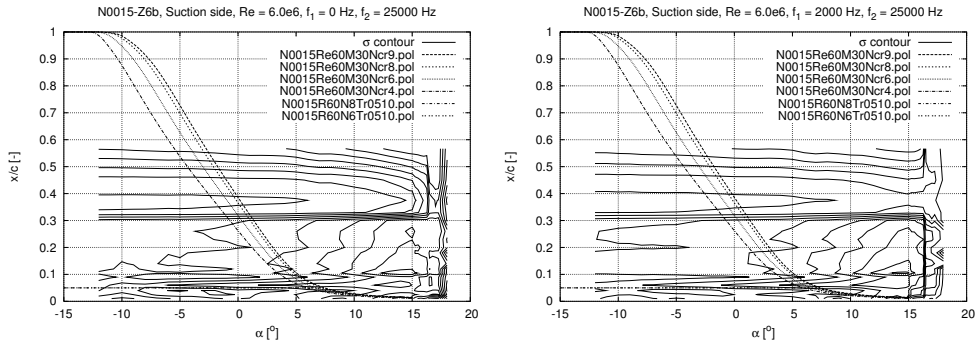

Figure 153: Contours of σ and XFoil data

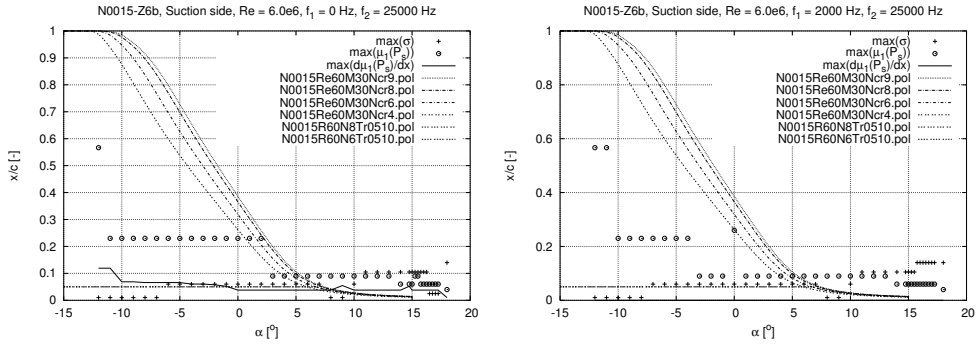

Figure 154: Transition detection

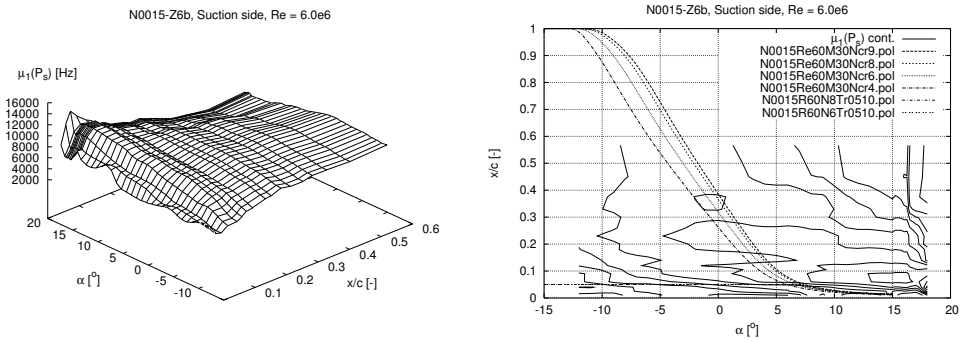

Figure 155: Fourier transform mean, $\mu_1(P_s)$

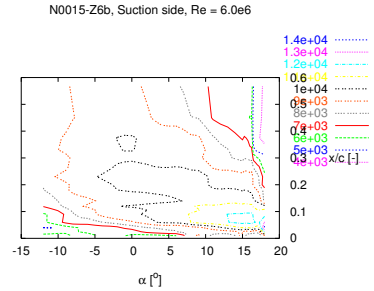

Figure 156: Contours of $\mu_1(P_s)$

```
N0015-Z6b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.1191     25021.7    8808.9
-11.00  0.1191     27665.3    8860.8
-10.00  0.0687     28365.0    9099.1
 -9.00  0.0687     31487.4    9335.6
 -8.00  0.0659     37082.7    9602.8
 -7.00  0.0659     39530.5    9750.5
 -6.00  0.0659     41167.9    9839.8
 -5.00  0.0659     43451.9    9956.2
 -4.00  0.0604     47410.0   10112.1
 -3.00  0.0604     53777.7   10256.0
 -2.00  0.0576     58758.2   10386.5
 -1.00  0.0520     59951.0   10436.7
  0.00  0.0380     56578.8   10476.2
  1.00  0.0380     63350.3   10457.2
  2.00  0.0380     68952.4   10450.9
  3.00  0.0380     74818.1   10462.5
  4.00  0.0380     77144.6   10632.0
  5.00  0.0380     75792.9   10641.8
  6.00  0.0380     73747.2   10640.4
```

```
 7.00  0.0380     64522.0   10793.3
 8.00  0.0380     40886.8   11102.7
 9.00  0.0548     44626.5   11376.9
10.00  0.0380     52771.1   11565.9
11.00  0.0380     66505.8   11667.2
12.00  0.0380     75139.2   11853.6
13.00  0.0380     77938.8   12015.6
14.00  0.0380     70923.6   12129.1
14.75  0.0520     51080.6   12231.5
15.00  0.0380     62403.1   12269.9
15.25  0.0380     67327.2   12203.8
15.50  0.0380     73436.4   12208.8
15.75  0.0380     80787.1   12219.7
16.00  0.0380     87658.5   12240.5
16.25  0.0380     87117.2   12233.4
16.50  0.0380     79936.9   12083.6
16.75  0.0380     81988.9   11994.5
17.00  0.0380     79677.5   11879.5
17.25  0.0380     78611.6   11934.3
18.00  0.0100     74270.3   14378.0
```

4.27 T16b Trip wire. Bump tape 2% 100x100

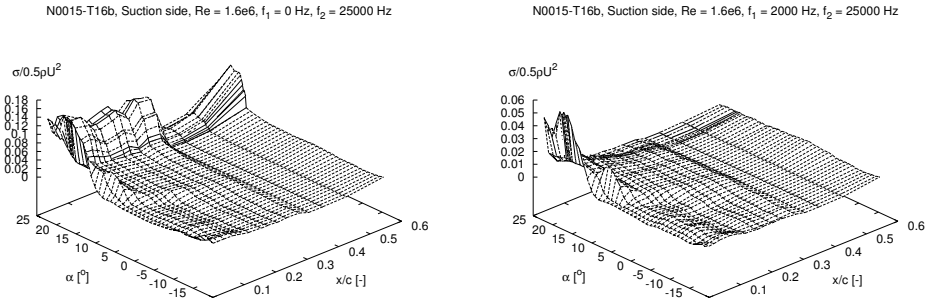

Figure 157: Pressure standard deviations, σ

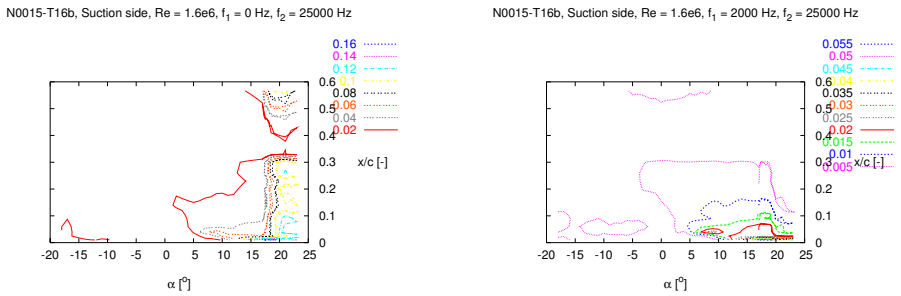

Figure 158: Contours of σ

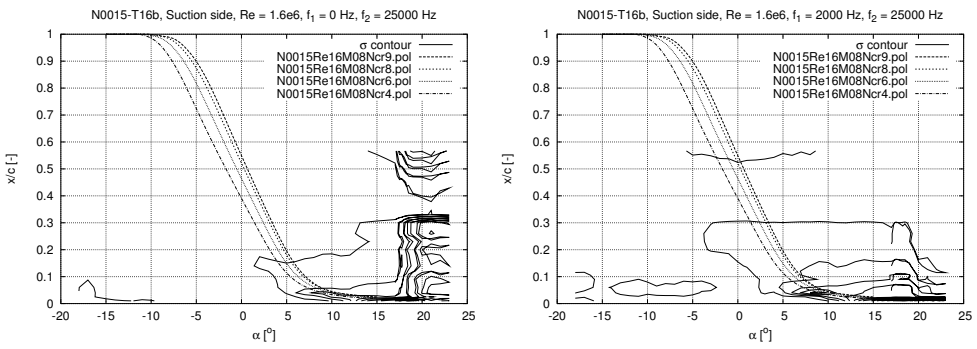

Figure 159: Contours of σ and XFoil data

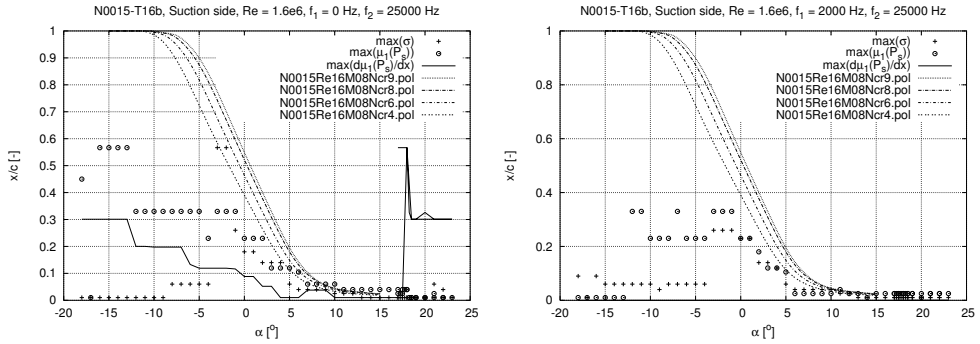

Figure 160: Transition detection

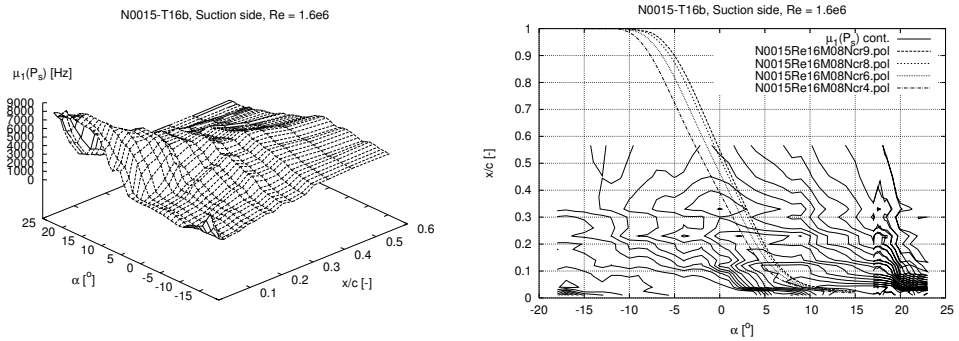

Figure 161: Fourier transform mean, $\mu_1(P_s)$

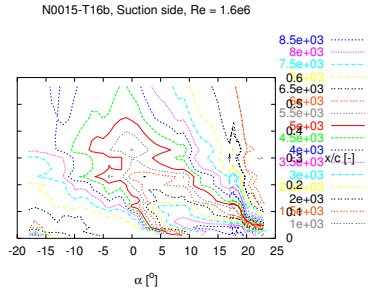

Figure 162: Contours of $\mu_1(P_s)$

```
N0015-T16b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 17.00  0.5667      1572.2    8765.7
 17.25  0.5667      1636.6    8706.3
 17.50  0.5667      1668.0    8544.8
 17.75  0.5667      1688.1    8660.8
 18.00  0.5667      1566.0    8579.1
 18.25  0.3261      1520.5    8592.6
 18.50  0.3009      3181.4    8629.2
 19.00  0.3009      2653.6    8698.7
 20.00  0.3261      3040.6    8180.2
 21.00  0.3009      3414.8    8087.3
 22.00  0.3009      4440.5    7854.5
 23.00  0.3009      4052.2    8113.9
 22.00  0.3009      4406.5    7817.6
 21.00  0.3009      4103.9    8571.0
 20.00  0.3009      3441.0    8316.1
 19.00  0.3009      1474.7    8683.2
 18.50  0.3009      1932.2    8628.0
 18.00  0.5667      1536.9    8645.1
 17.50  0.0100      2805.5    8681.5
```

17.00	0.0100	2921.8	8804.5
16.00	0.0100	5785.5	8799.5
15.00	0.0100	8221.4	8767.7
14.00	0.0100	9933.3	8700.2
13.00	0.0100	13313.5	8712.7
12.00	0.0100	23161.4	8802.5
11.00	0.0100	29896.8	8600.6
10.00	0.0100	33216.8	8287.7
9.00	0.0380	51877.3	8397.3
8.00	0.0380	61631.1	8225.2
7.00	0.0380	50864.6	7889.4
6.00	0.0100	46358.4	7612.2
5.00	0.0100	60876.5	7596.4
4.00	0.0100	73883.8	7355.0
3.00	0.0520	58621.4	6888.9
2.00	0.0520	48929.3	6517.6
1.00	0.0883	41231.1	6384.6
0.00	0.0883	42243.3	6290.3
-1.00	0.1163	27168.9	5911.7
-2.00	0.1191	21205.4	5621.4
-3.00	0.1191	23965.8	5593.6
-4.00	0.1191	26772.8	5574.8
-5.00	0.1191	21882.2	5256.2
-6.00	0.1331	19021.3	5215.2
-7.00	0.1974	19572.0	5137.4
-8.00	0.1974	20643.4	4846.9
-9.00	0.1974	20015.2	4765.9
-10.00	0.1974	17668.2	4687.7
-11.00	0.2002	15974.6	4380.2
-12.00	0.2002	12282.7	4126.4
-13.00	0.3009	13743.7	4073.6
-14.00	0.3009	14503.8	4045.9
-15.00	0.3009	14083.5	3888.6
-16.00	0.3009	13998.1	3834.7
-17.00	0.3009	13672.4	4790.1
-18.00	0.3009	14633.2	3788.3

4.28 T3b Trip wire. Bump tape 2% 100x100

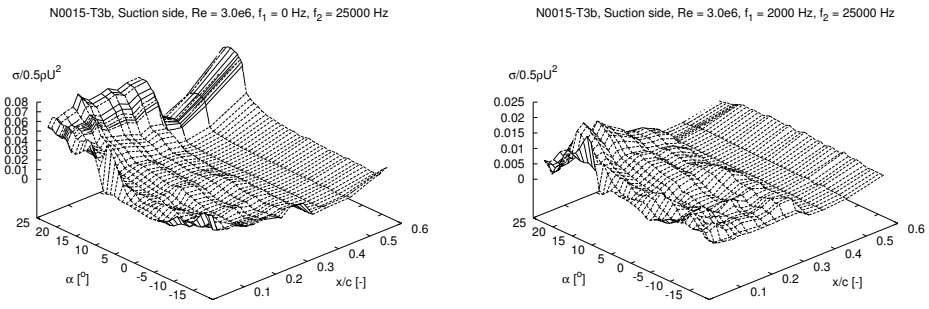

Figure 163: Pressure standard deviations, σ

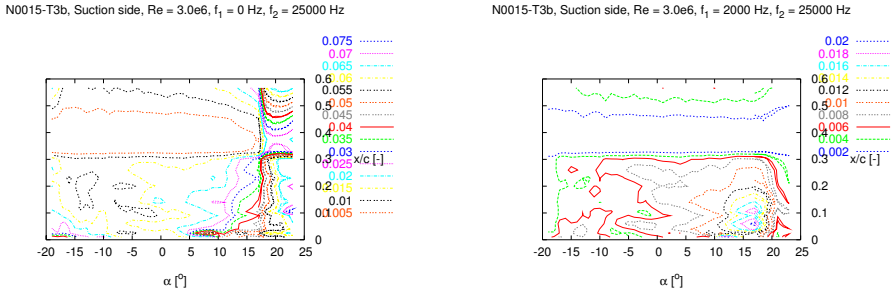

Figure 164: Contours of σ

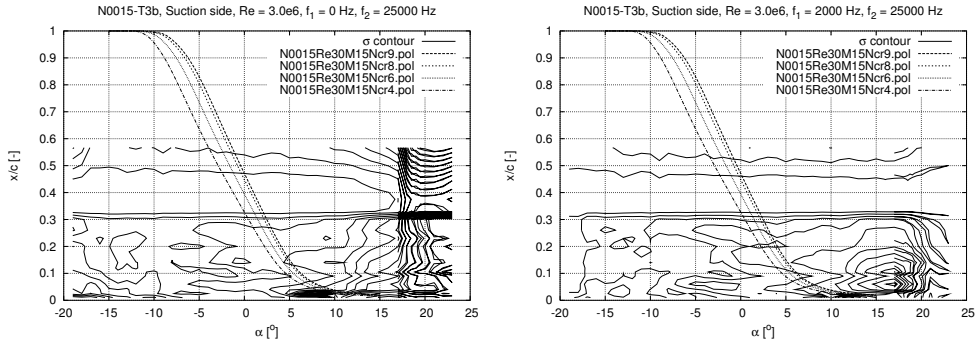

Figure 165: Contours of σ and XFoil data

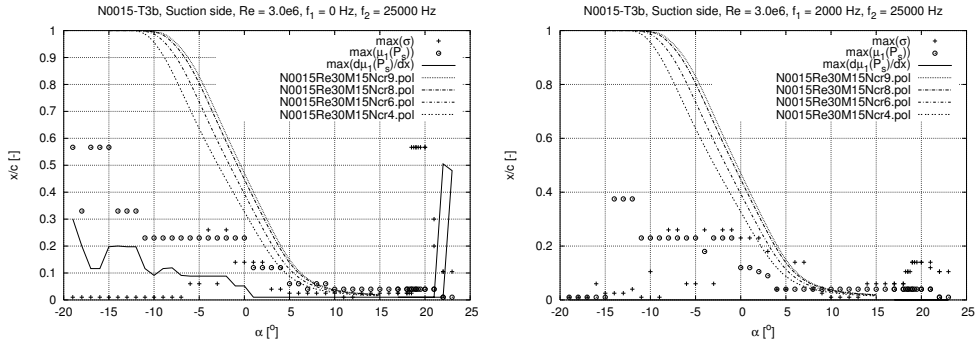

Figure 166: Transition detection

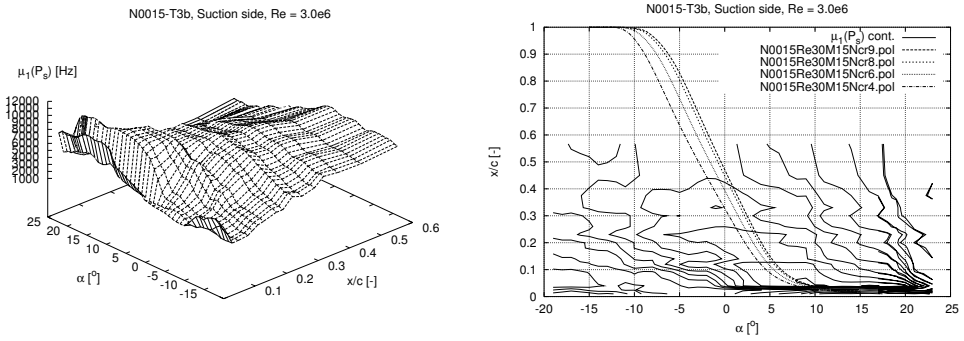

Figure 167: Fourier transform mean, $\mu_1(P_s)$

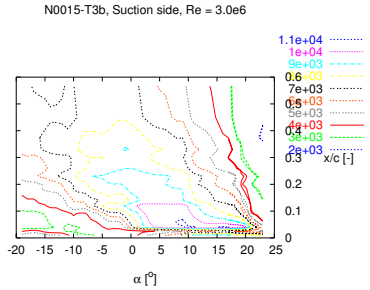

Figure 168: Contours of $\mu_1(P_s)$

```
N0015-T3b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
17.00	0.0100	77449.5	10978.0
18.00	0.0100	84990.1	10754.9
18.25	0.0100	88704.0	10830.5
18.50	0.0100	89540.7	10840.8
18.75	0.0100	89758.4	10813.0
19.00	0.0100	89577.1	10778.7
19.25	0.0100	87644.8	10668.6
20.00	0.0100	79519.0	10264.6
21.00	0.0100	45723.1	8626.0
22.00	0.5051	5099.7	8272.3
23.00	0.4799	5634.8	7854.4
22.00	0.0100	12401.7	8381.6
21.00	0.0100	41936.6	8226.3
20.00	0.0100	79991.7	10243.1
19.50	0.0100	87658.6	10625.0
19.00	0.0100	87700.8	10651.2
18.50	0.0100	90204.5	10766.7
18.00	0.0100	88226.4	10816.2
17.00	0.0100	81959.8	11023.0
16.00	0.0100	83000.3	11171.0
15.00	0.0100	83064.1	10973.8
14.00	0.0100	84559.5	10680.8
13.00	0.0100	82518.4	10576.5
12.00	0.0100	82906.0	10818.5
11.00	0.0100	85783.7	11090.0
10.00	0.0100	94104.0	11042.9
9.00	0.0100	117422.7	11089.7
8.00	0.0100	128283.3	11035.4
7.00	0.0100	130605.5	10820.1
6.00	0.0100	132466.8	10727.2
5.00	0.0100	132990.8	10698.7
4.00	0.0100	127192.4	10475.6
3.00	0.0100	120539.5	10484.2
2.00	0.0100	112995.1	10403.8
1.00	0.0100	95467.1	10003.8
0.00	0.0520	77386.6	9764.7
-1.00	0.0520	62732.9	9705.2
-2.00	0.0883	60827.6	9490.4
-3.00	0.0883	62212.3	9436.5
-4.00	0.0883	62608.4	9289.3
-5.00	0.0883	60777.9	9107.4
-6.00	0.0883	54337.0	9050.0
-7.00	0.0911	48982.5	8984.3
-8.00	0.1191	42778.8	8621.9
-9.00	0.1163	43284.8	8337.0
-10.00	0.0911	37995.7	7882.5
-11.00	0.1163	31602.5	7550.0
-12.00	0.1974	30129.3	7483.1
-13.00	0.1974	31700.1	7511.4
-14.00	0.2002	27971.0	7431.8
-15.00	0.1974	23335.1	7180.3
-16.00	0.1163	24891.5	7152.8
-17.00	0.1163	24367.3	7097.7
-18.00	0.2002	24102.7	6883.2
-19.00	0.3009	24282.6	6764.9

4.29 T6b Trip wire. Bump tape 2% 100x100

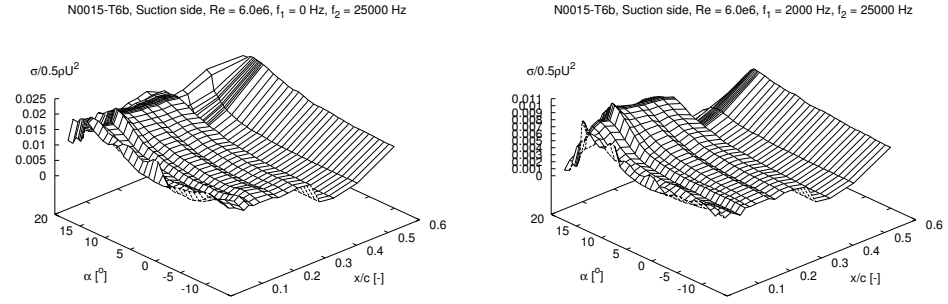

Figure 169: Pressure standard deviations, σ

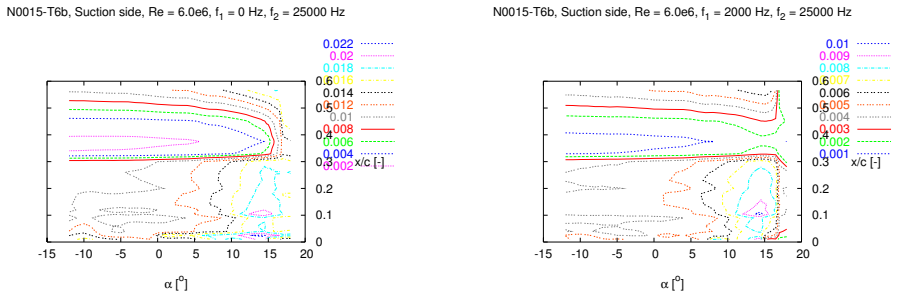

Figure 170: Contours of σ

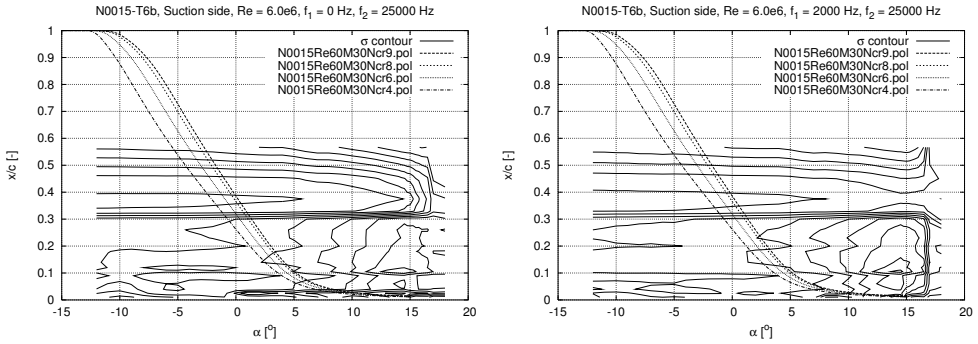

Figure 171: Contours of σ and XFoil data

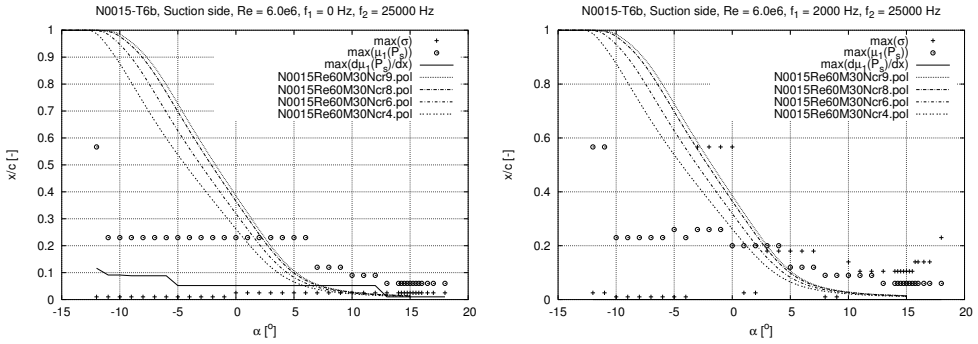

Figure 172: Transition detection

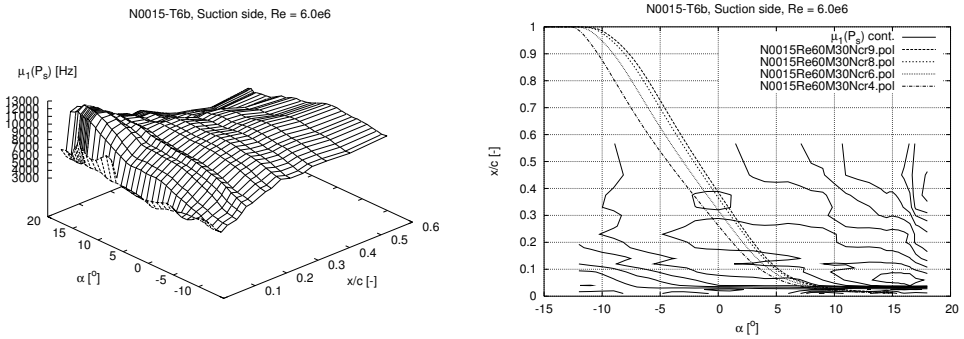

Figure 173: Fourier transform mean, $\mu_1(P_s)$

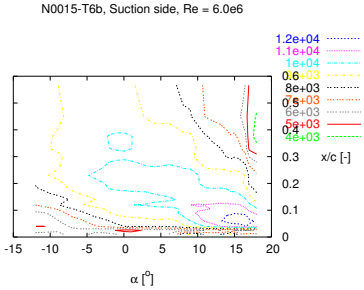

Figure 174: Contours of $\mu_1(P_s)$

```
N0015-T6b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.1163     24879.4    8820.2
-11.00  0.0911     28490.2    8818.3
-10.00  0.0911     30368.1    9049.5
 -9.00  0.0883     32472.2    9280.6
 -8.00  0.0883     34291.2    9543.5
 -7.00  0.0883     35736.1    9736.1
 -6.00  0.0883     36115.7    9902.3
 -5.00  0.0520     36790.0    9968.2
 -4.00  0.0520     45155.4   10116.4
 -3.00  0.0520     51918.0   10268.3
 -2.00  0.0520     58450.5   10400.5
 -1.00  0.0520     68104.7   10449.5
  0.00  0.0520     75057.4   10482.9
  1.00  0.0520     77435.8   10493.2
  2.00  0.0520     73013.4   10453.3
  3.00  0.0520     69107.7   10403.7
  4.00  0.0520     68908.9   10402.0
  5.00  0.0520     67816.0   10434.7
  6.00  0.0520     66485.8   10494.1
  7.00  0.0520     67899.0   10506.5
  8.00  0.0520     73371.8   10773.1
  9.00  0.0520     81619.4   10993.1
 10.00  0.0520     87398.3   11128.6
 11.00  0.0520     87229.9   11334.0
 12.00  0.0520     92443.6   11609.1
 13.00  0.0100     98367.3   11913.3
 14.00  0.0100    103457.8   12218.1
 14.25  0.0100     99334.5   12262.4
 14.50  0.0100     95498.9   12312.3
 14.75  0.0100    104178.7   12354.3
 15.00  0.0100    110307.2   12392.7
 15.25  0.0100    112964.9   12428.0
 15.50  0.0100    117064.6   12427.5
 15.75  0.0100    124581.6   12501.2
 16.00  0.0100    126555.7   12472.1
 16.50  0.0100    129930.2   12568.8
 17.00  0.0100    124075.0   12187.0
 18.00  0.0100    118181.2   11915.6
```

5 Pressure side

5.1 C16 Clean -

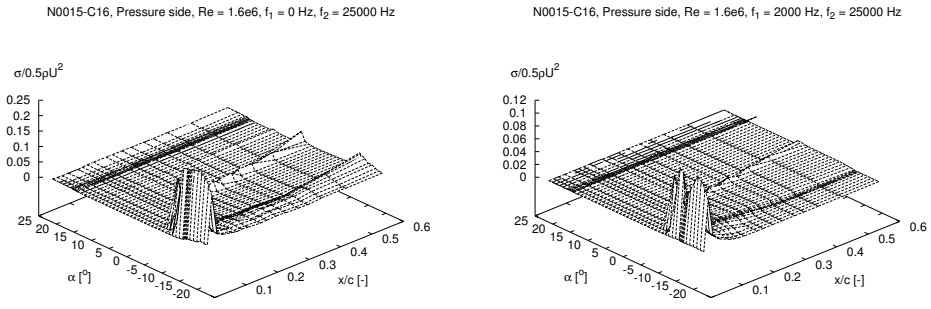

Figure 175: Pressure standard deviations, σ

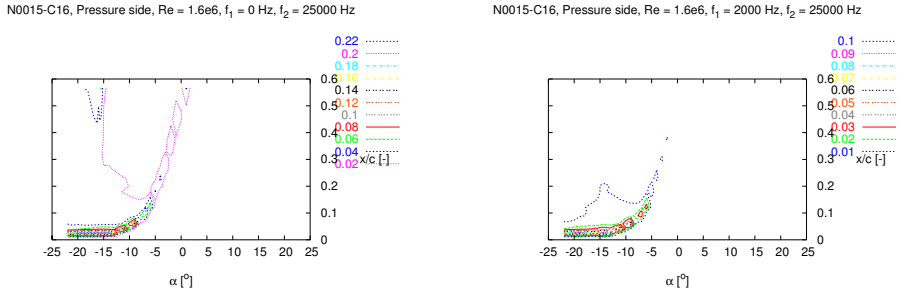

Figure 176: Contours of σ

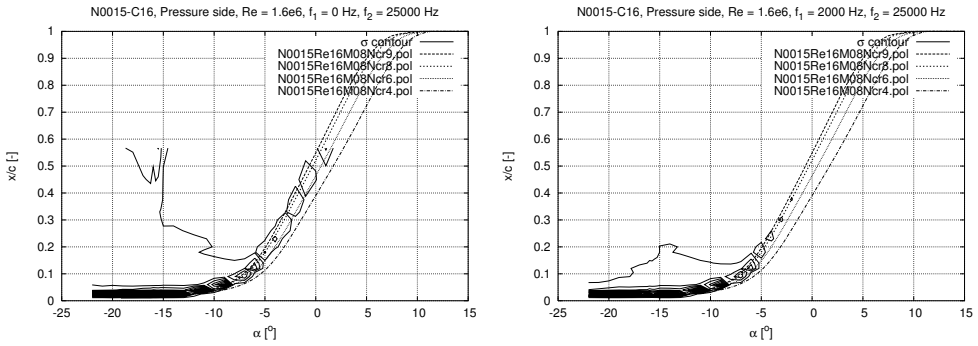

Figure 177: Contours of σ and XFoil data

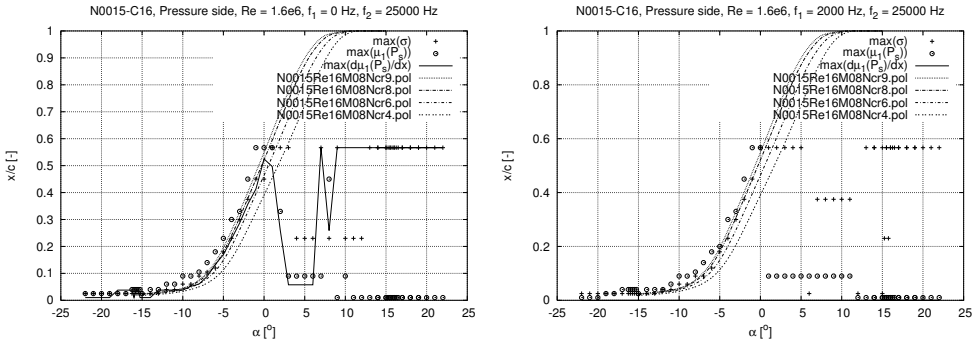

Figure 178: Transition detection

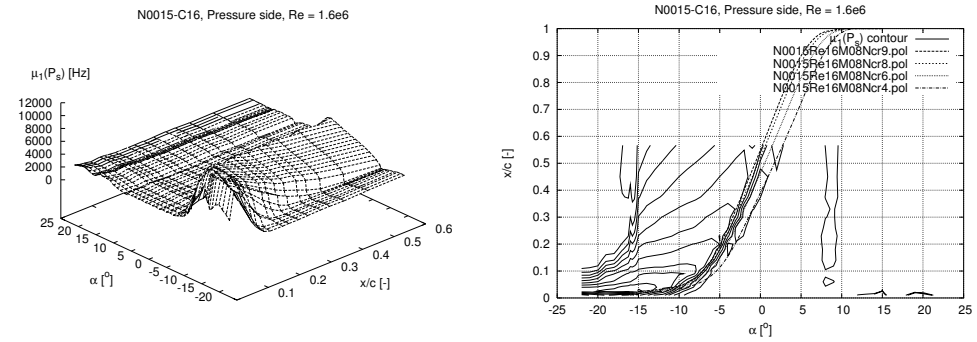

Figure 179: Fourier transform mean, $\mu_1(P_s)$

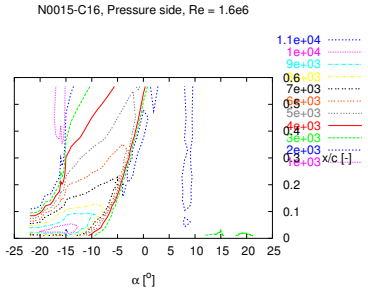

Figure 180: Contours of $\mu_1(P_s)$

```
N0015-C16
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 14.00  0.5667      2254.8    3102.0
 15.00  0.5667      2168.9    3587.7
 15.25  0.5667      2256.6    3085.5
 15.50  0.5667      2106.0    3002.2
 15.75  0.5667      2209.0    2904.4
 16.00  0.5667      2126.4    2826.2
 16.26  0.5667      2149.6    2681.7
 17.00  0.5667      2164.8    2756.1
 18.00  0.5667      2210.5    2968.1
 19.00  0.5667      2253.7    3219.8
 20.00  0.5667      2237.5    3249.2
 21.00  0.5667      2254.2    3048.2
 22.00  0.5667      2250.5    2868.5
 19.00  0.5667      2238.8    3304.5
 18.00  0.5667      2213.7    3028.3
 17.00  0.5667      2172.2    2770.1
 16.50  0.5667      2165.7    2697.4
 16.00  0.5667      2207.4    2837.6
 15.50  0.5667      2145.9    2990.4
```

15.00	0.5667	2343.5	3438.5
14.00	0.5667	2303.6	3162.9
13.00	0.5667	2383.3	3096.2
12.00	0.5667	2287.5	3036.6
11.00	0.5667	2330.4	2589.4
10.00	0.5667	2245.4	2461.9
9.00	0.5667	1707.6	2238.8
8.00	0.2590	2421.2	2086.4
7.00	0.5667	2251.8	2414.5
6.00	0.0576	2238.6	2345.2
5.00	0.0576	2703.2	2428.2
4.00	0.0576	2376.6	2331.2
3.00	0.0576	2821.6	2434.0
2.00	0.2590	2226.6	2281.5
1.00	0.4967	3884.3	2535.5
0.00	0.5247	32640.6	4847.6
-1.00	0.4128	41306.5	5075.6
-2.00	0.3569	54069.6	5626.1
-3.00	0.2869	64976.6	5967.1
-4.00	0.2282	75329.9	6555.0
-5.00	0.1694	77768.4	7017.0
-6.00	0.1331	68114.5	7404.0
-7.00	0.0883	73494.7	7850.6
-8.00	0.0604	80060.5	8185.1
-9.00	0.0520	84179.4	8911.9
-10.00	0.0380	85132.2	9098.8
-11.00	0.0380	86515.3	9523.8
-12.00	0.0380	44815.4	9220.5
-13.00	0.0380	46137.7	10244.7
-14.00	0.0100	22282.9	10787.3
-15.00	0.0100	6443.6	11221.8
-15.25	0.0100	29631.2	10732.9
-15.50	0.0380	32170.2	10579.7
-15.75	0.0380	40280.7	10595.4
-16.00	0.0100	36910.2	10731.5
-16.25	0.0380	50500.9	10404.8
-17.00	0.0380	41357.3	10438.5
-18.00	0.0380	17039.4	10424.4
-19.00	0.0100	8632.8	10292.6
-20.00	0.0100	7378.5	10061.8
-21.00	0.0100	12679.5	9685.8
-22.00	0.0100	18495.9	9647.3

5.2 C3 Clean -

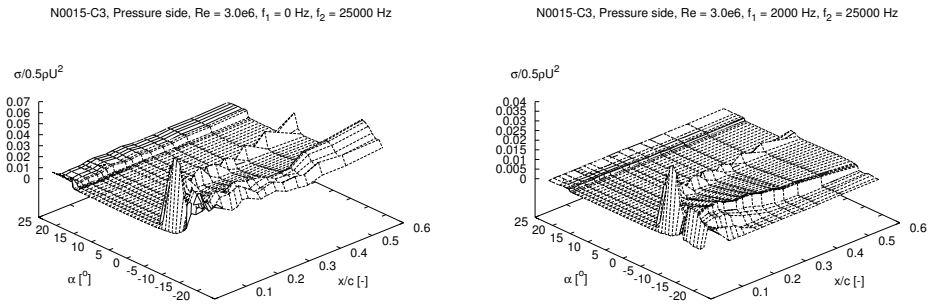

Figure 181: Pressure standard deviations, σ

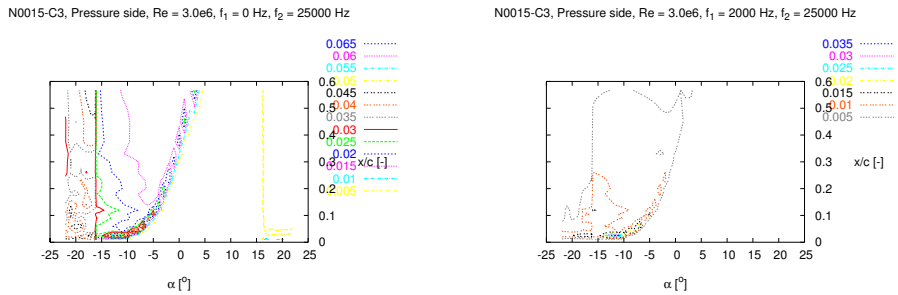

Figure 182: Contours of σ

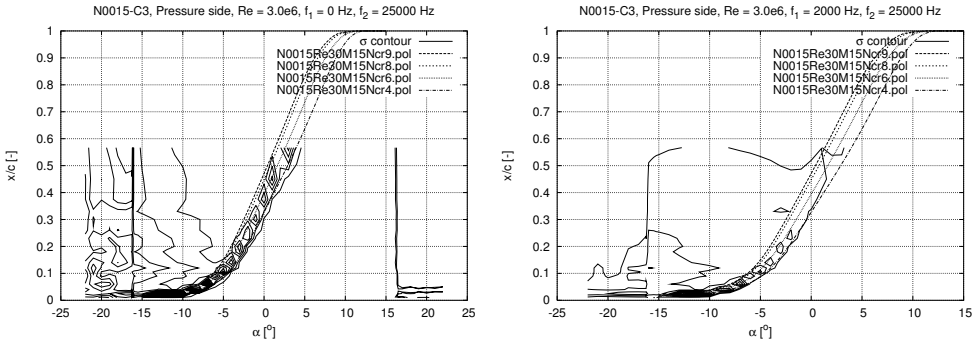

Figure 183: Contours of σ and XFoil data

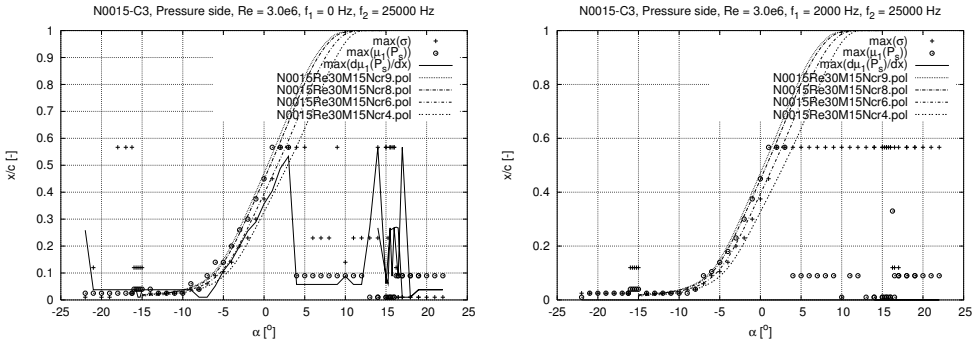

Figure 184: Transition detection

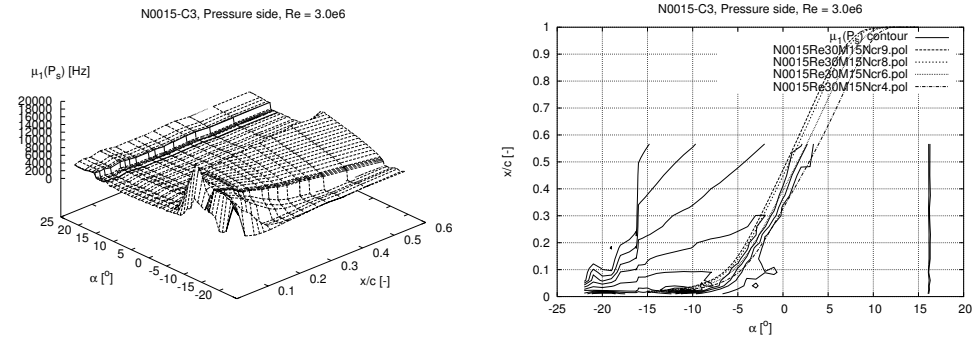

Figure 185: Fourier transform mean, $\mu_1(P_s)$

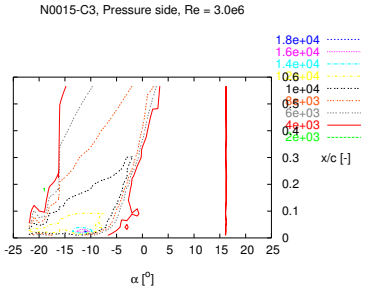

Figure 186: Contours of $\mu_1(P_s)$

```
N0015-C3
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
14.00	0.2674	3350.1	3640.7
15.00	0.0883	3231.8	3439.7
15.25	0.0604	3712.8	3525.6
15.50	0.2674	3216.4	3516.8
15.75	0.0883	3494.9	3627.1
16.00	0.2674	3165.5	3678.6
16.25	0.2702	5727.3	5018.8
16.50	0.2674	4666.3	5149.5
17.00	0.0100	5075.1	5227.5
18.00	0.0100	6096.2	5277.6
19.00	0.0380	8988.1	5225.5
20.00	0.0380	10826.0	5337.6
21.00	0.0380	11420.7	5419.1
22.00	0.0380	10178.9	5490.9
19.00	0.0380	8838.6	5380.6
18.00	0.0100	6258.3	5346.9
17.00	0.5667	4742.0	5275.7
16.50	0.0883	4932.3	5219.1
16.00	0.2674	3365.0	3735.3
15.50	0.2590	3073.1	3586.0
15.00	0.0604	3875.2	3488.2
14.00	0.5667	3032.1	3487.2
13.00	0.2702	3389.7	3833.7
12.00	0.0576	4358.5	3343.7
11.00	0.0576	4966.5	3550.0
10.00	0.0883	3295.2	3202.6
9.00	0.0576	6195.3	3544.5
8.00	0.0576	5710.9	3456.2
7.00	0.0576	6255.5	3679.9
6.00	0.0576	5532.2	3507.3
5.00	0.0576	6136.5	3774.8
4.00	0.0576	5249.0	3537.4
3.00	0.5331	11769.7	4990.6
2.00	0.4883	51088.2	8401.6
1.00	0.4044	39873.9	8764.3
0.00	0.3569	66706.1	9361.0
-1.00	0.2897	81623.3	9632.0
-2.00	0.2562	90780.0	10023.0
-3.00	0.2002	92958.6	10182.7
-4.00	0.1471	87421.6	10831.9
-5.00	0.1079	77871.5	11177.4
-6.00	0.0520	95668.0	11176.6
-7.00	0.0100	115048.6	11948.8
-8.00	0.0100	145819.5	12600.5
-9.00	0.0380	124024.0	12184.4
-10.00	0.0380	95174.9	14649.0
-11.00	0.0380	92079.4	18314.7
-12.00	0.0380	36570.2	17543.6
-13.00	0.0380	49606.5	15479.4
-14.00	0.0380	58217.8	13047.8
-15.00	0.0380	64288.1	12853.5
-15.25	0.0100	54227.0	12867.6
-15.50	0.0100	53434.0	12910.8
-15.75	0.0380	54570.2	12824.7
-16.00	0.0380	64344.1	12776.5
-16.25	0.0380	53034.5	13967.8
-16.25	0.0380	52187.8	13718.4
-17.00	0.0380	48384.8	13710.3
-18.00	0.0380	55184.7	13524.7
-19.00	0.0380	52075.0	13815.4
-20.00	0.0380	35256.7	13251.0
-21.00	0.0380	57675.8	12782.4
-22.00	0.2590	6963.4	12471.4

5.3 C4 Clean -

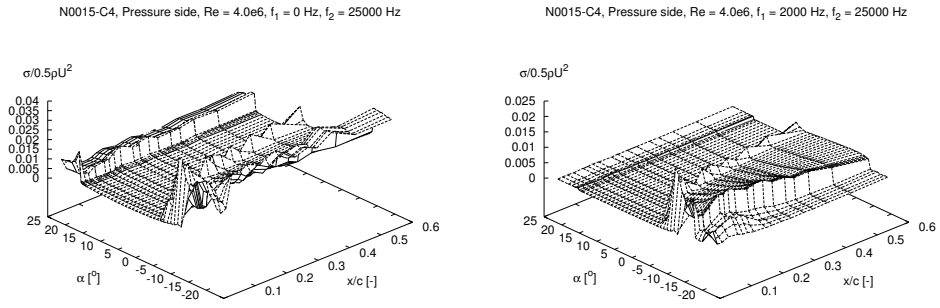

Figure 187: Pressure standard deviations, σ

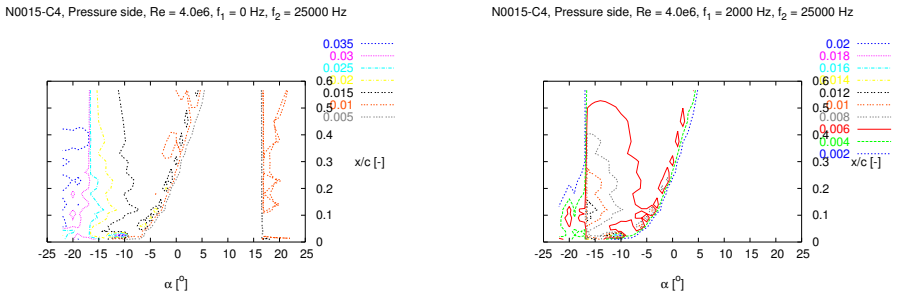

Figure 188: Contours of σ

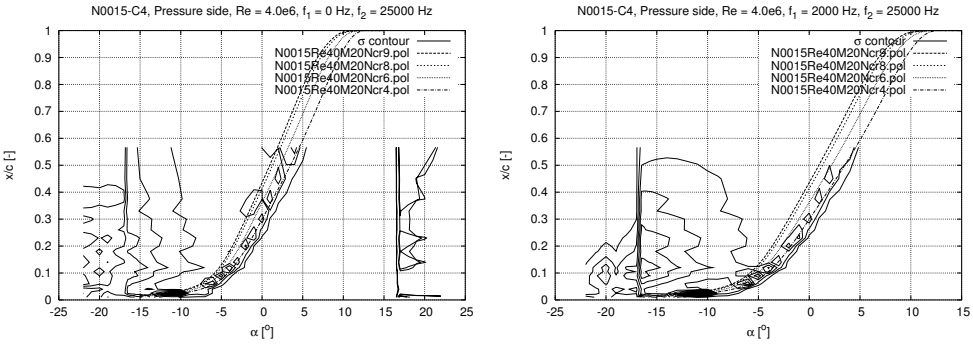

Figure 189: Contours of σ and XFoil data

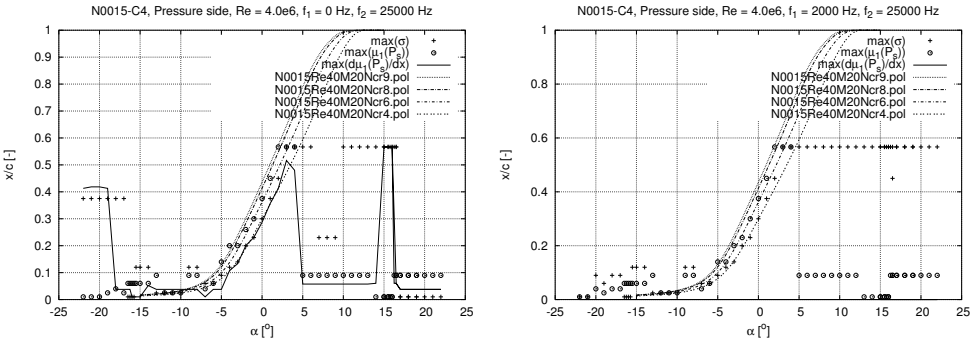

Figure 190: Transition detection

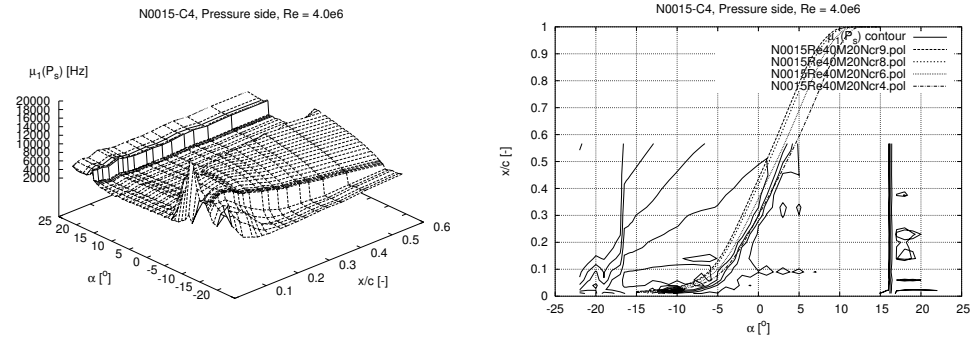

Figure 191: Fourier transform mean, $\mu_1(P_s)$

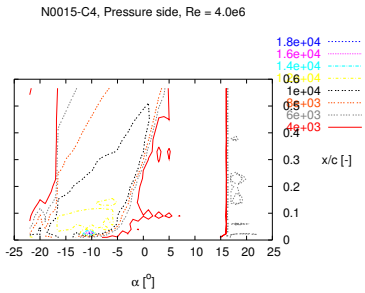

Figure 192: Contours of $\mu_1(P_s)$

```
N0015-C4
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 15.00  0.5667      3293.4    4007.3
 15.50  0.5667      3319.7    4310.8
 15.75  0.5667      3452.7    4483.0
 16.00  0.5667      3336.1    4564.4
 16.25  0.0604      8733.2    7130.8
 16.50  0.0604      8431.9    7164.1
 17.00  0.0380     12206.9    6857.1
 18.00  0.0380     17715.3    6818.8
 19.00  0.0380     19165.6    6793.4
 20.00  0.0380     21360.5    6862.0
 21.00  0.0380     20262.5    6909.5
 22.00  0.0380     14137.2    7010.9
 19.00  0.0380     17495.8    6852.4
 18.00  0.0380     18215.4    6760.5
 17.00  0.0380     11382.5    6821.1
 16.50  0.0604      7842.9    7181.7
 16.00  0.5667      3443.9    4606.8
 15.50  0.5667      3290.8    4279.6
 15.00  0.5667      3450.8    4072.3
 14.00  0.0604      3826.4    3574.2
 13.00  0.0576      5775.6    3747.9
 12.00  0.0576      5937.0    3620.2
 11.00  0.0576      6877.3    3802.1
 10.00  0.0576      5735.7    3566.9
  9.00  0.0576      5810.3    3937.1
  8.00  0.0576      6205.2    3838.8
  7.00  0.0576      6905.8    4011.8
  6.00  0.0576      6502.9    3898.2
  5.00  0.0576      6744.5    4121.2
  4.00  0.4799     24884.8    6635.9
  3.00  0.5163     51742.3    9730.3
  2.00  0.4128     61586.5    9811.3
  1.00  0.3569     70618.8   10435.3
  0.00  0.2869     89987.0   10758.4
 -1.00  0.2310     92772.4   11156.4
 -2.00  0.2002    100383.2   11302.8
 -3.00  0.1331     76453.5   11771.3
 -4.00  0.1079     82280.1   11875.5
 -5.00  0.0380     99072.3   11976.9
 -6.00  0.0380    148782.8   12646.5
 -7.00  0.0100    163424.3   13072.7
 -8.00  0.0380    141845.7   12742.5
 -9.00  0.0380    132797.7   12760.4
-10.00  0.0380    120368.6   19277.1
-11.00  0.0380     94219.5   17601.1
-12.00  0.0380    122078.5   12811.5
-13.00  0.0380     77892.6   12615.0
-14.00  0.0520     26739.5   12634.5
-15.00  0.0100     24031.0   12646.0
-15.50  0.0100     26523.6   12684.6
-15.75  0.0100     26782.2   12706.4
-16.00  0.0100     30308.3   12695.9
-16.25  0.0380     40875.6   12723.5
-16.50  0.0380     43504.0   12683.9
-17.00  0.0380     25295.9   11171.9
-18.00  0.0380     34784.9   10764.9
-19.00  0.4128      6264.9    9845.6
-20.00  0.4184      6504.3   10405.5
-21.00  0.4184      6773.2   11471.4
-22.00  0.4128      6952.1   12999.3
```

5.4 C5 Clean -

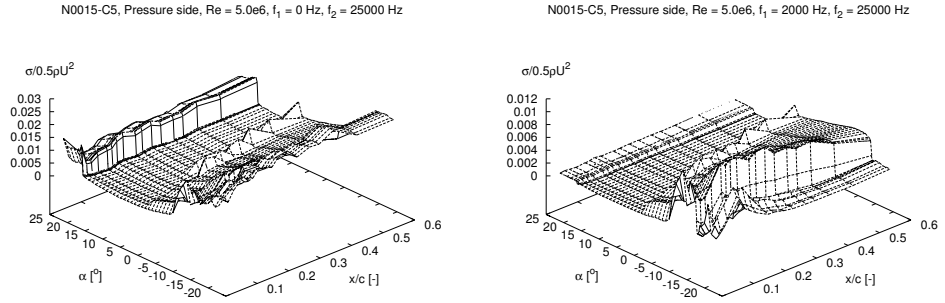

Figure 193: Pressure standard deviations, σ

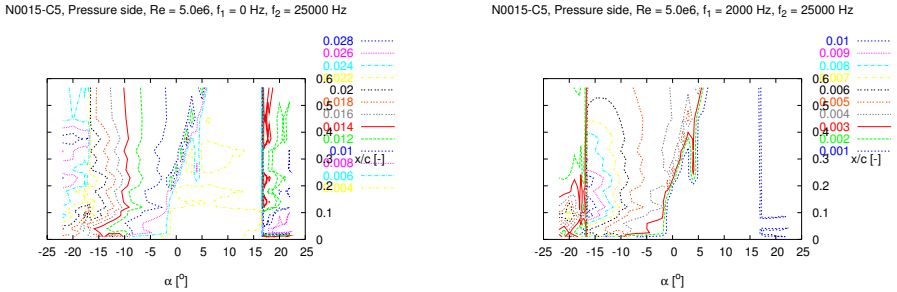

Figure 194: Contours of σ

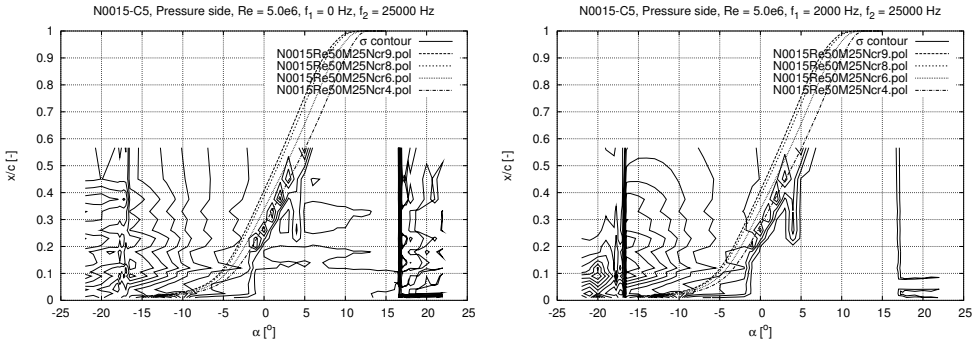

Figure 195: Contours of σ and XFoil data

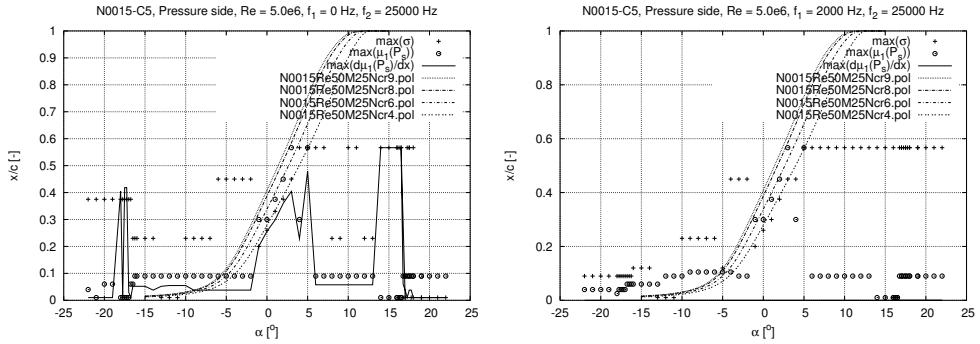

Figure 196: Transition detection

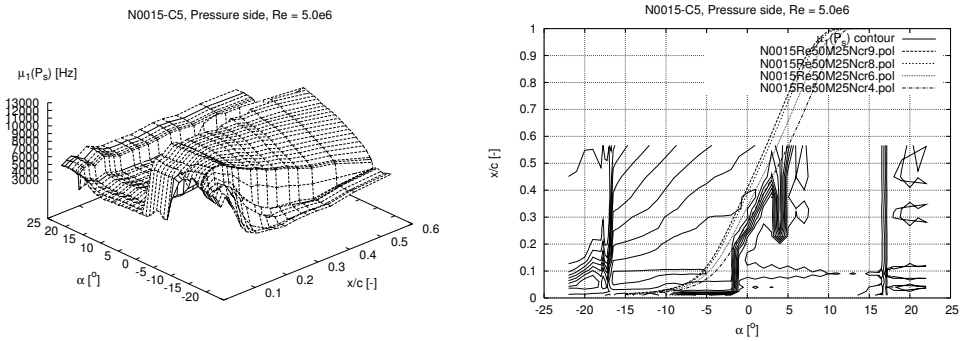

Figure 197: Fourier transform mean, $\mu_1(P_s)$

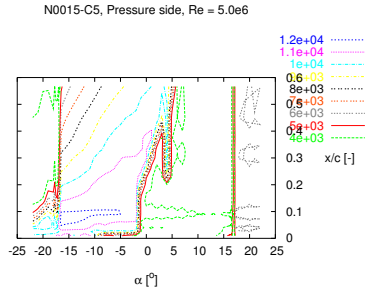

Figure 198: Contours of $\mu_1(P_s)$

```
N0015-C5
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.5667      3562.7    5184.8
 16.25  0.5667      3574.8    5166.7
 16.50  0.5667      3797.4    5243.2
 16.75  0.0604      4001.8    3914.2
 17.00  0.0380      8256.2    4108.4
 17.25  0.0100      8852.6    6243.1
 17.50  0.0380      9008.8    6202.3
 17.75  0.0380     10370.4    6341.7
 18.00  0.0100      8089.8    6274.9
 19.00  0.0100      8566.3    6409.3
 20.00  0.0100      9397.6    6651.1
 21.00  0.0100      8143.6    6448.4
 22.00  0.0100     10478.1    6493.3
 19.00  0.0100      8625.7    6457.1
 18.00  0.0100      8647.4    6463.9
 17.50  0.0100      8014.9    6347.4
 17.00  0.0100      8643.6    6252.0
 16.50  0.5667      3800.5    5232.7
 16.00  0.5667      3578.4    5086.8
```

15.00	0.5667	3715.3	4794.7
14.00	0.5667	3542.3	4148.6
13.00	0.0576	6265.3	4044.3
12.00	0.0576	6603.9	3911.9
11.00	0.0576	7338.6	4041.9
10.00	0.0576	7269.8	3997.7
9.00	0.0576	7544.3	4184.9
8.00	0.0576	6885.1	4075.3
7.00	0.0576	6751.6	4289.0
6.00	0.0576	6122.7	4153.8
5.00	0.4799	30992.9	7785.9
4.00	0.2282	112195.9	10980.8
3.00	0.4044	65276.6	10291.1
2.00	0.3597	64676.2	10889.3
1.00	0.2981	71939.7	11063.5
0.00	0.2562	93329.5	11271.9
-1.00	0.2002	85934.5	11369.6
-2.00	0.0380	125923.8	11951.8
-3.00	0.0380	121843.1	11963.8
-4.00	0.0380	113557.7	11976.4
-5.00	0.0380	102681.4	11996.9
-6.00	0.0380	103984.5	12065.4
-7.00	0.0380	115498.2	12023.8
-8.00	0.0380	117561.5	12088.9
-9.00	0.0380	73790.0	12044.6
-10.00	0.0548	38884.8	12103.4
-11.00	0.0548	29680.4	12161.3
-12.00	0.0548	27069.6	12242.9
-13.00	0.0520	28096.8	12231.1
-14.00	0.0380	36477.6	12215.2
-15.00	0.0520	28101.6	12249.0
-16.00	0.0520	29286.9	12256.9
-16.25	0.0520	29158.2	12254.2
-16.50	0.0520	30194.3	12255.5
-16.75	0.0100	23270.9	11813.8
-17.00	0.0296	8883.9	11428.0
-17.25	0.4184	7380.3	11132.6
-17.50	0.4184	8173.6	11019.9
-17.75	0.0100	11661.4	10710.7
-18.00	0.4044	7987.8	10710.1
-19.00	0.0100	11615.7	10667.6
-20.00	0.0100	26451.4	10868.3
-21.00	0.0100	15920.4	10431.5
-22.00	0.0100	16905.0	10308.9

5.5 C6 Clean -

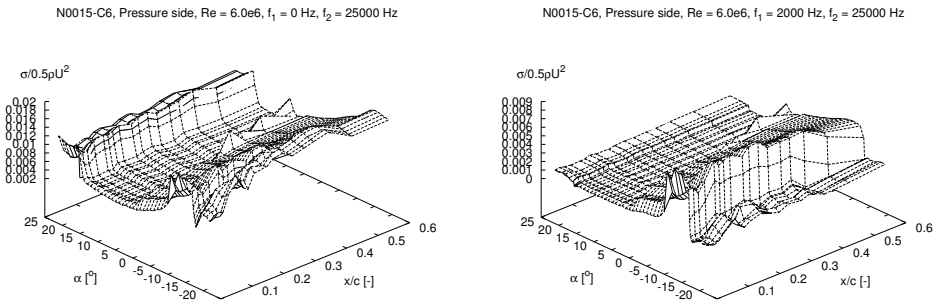

Figure 199: Pressure standard deviations, σ

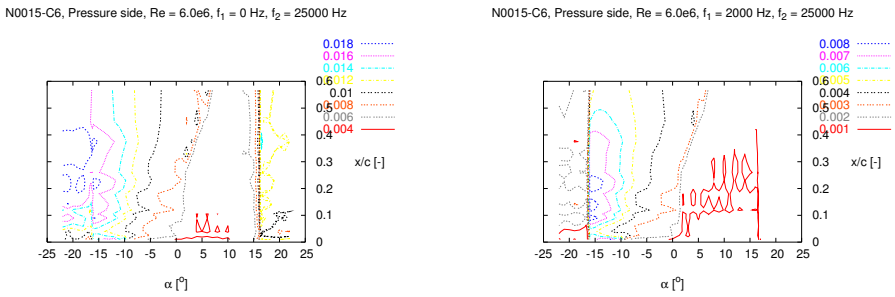

Figure 200: Contours of σ

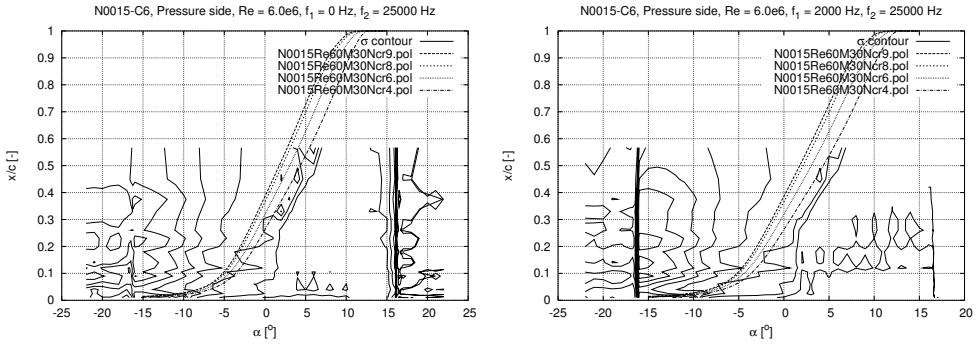

Figure 201: Contours of σ and XFoil data

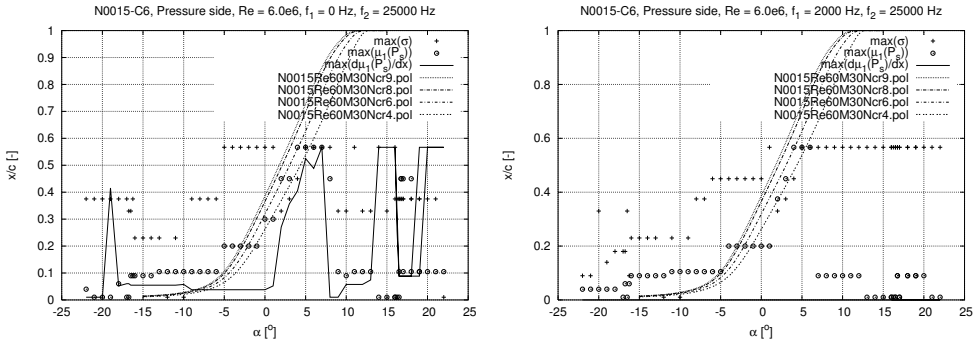

Figure 202: Transition detection

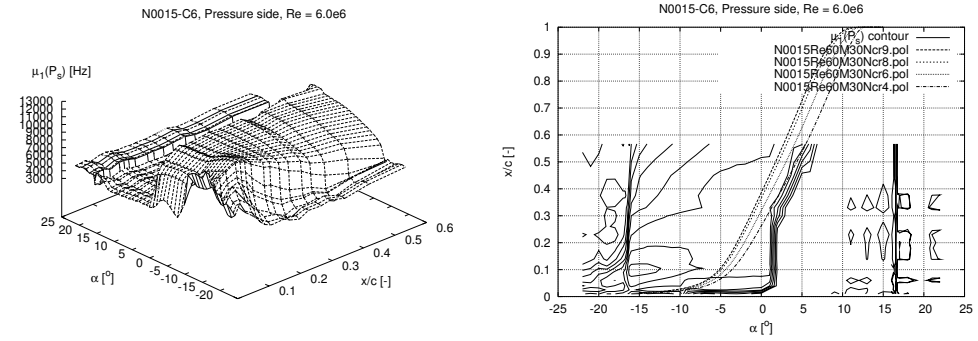

Figure 203: Fourier transform mean, $\mu_1(P_s)$

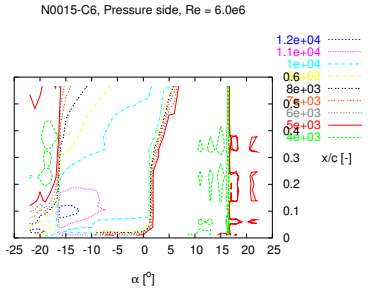

Figure 204: Contours of $\mu_1(P_s)$

N0015-C6
alpha [degrees] angle of attack
xtr* [-] transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx* [Hz/-] d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1) [Hz] max mu1 of all chordwise positions

alpha	xtr*	d(mu1)/dx*	max(mu1)
16.00	0.5667	3926.2	5510.5
16.25	0.2590	3910.3	5380.9
16.50	0.0883	6485.8	4172.5
16.75	0.0883	6643.9	5366.4
17.00	0.0883	6485.1	5338.0
18.00	0.0883	6369.4	5355.1
19.00	0.0883	5787.7	5476.1
20.00	0.5667	5457.4	5588.5
21.00	0.5667	5302.9	5341.0
22.00	0.5667	5274.8	5336.5
19.00	0.5667	5479.0	5553.3
18.00	0.0883	6144.8	5320.5
17.00	0.0883	6194.5	5384.2
16.75	0.0883	6552.3	5312.7
16.50	0.0883	5590.8	4347.1
16.00	0.5667	4320.3	5431.2
15.00	0.5667	4049.5	5380.6
14.00	0.5667	4298.4	4793.0
13.00	0.0743	4155.5	4253.5
12.00	0.0576	6266.7	4453.7
11.00	0.0576	5053.8	4275.0
10.00	0.0576	5207.9	4498.4
9.00	0.0100	4926.6	4391.6
8.00	0.0100	5740.1	4563.3
7.00	0.5667	4581.4	4600.2
6.00	0.4883	24963.3	7572.8
5.00	0.5247	47160.4	10114.1
4.00	0.4044	48148.5	10269.9
3.00	0.3569	59066.8	10537.5
2.00	0.2702	50549.3	10759.5
1.00	0.0520	100808.1	10837.3
0.00	0.0380	92786.2	10890.0
-1.00	0.0380	84485.4	10904.2
-2.00	0.0380	71932.1	10925.1
-3.00	0.0380	67577.2	10949.6
-4.00	0.0380	68975.2	10896.4
-5.00	0.0380	78070.2	10942.4
-6.00	0.0380	86526.2	10908.9
-7.00	0.0380	93938.9	10975.5
-8.00	0.0380	77127.1	11068.7
-9.00	0.0380	57091.3	11261.9
-10.00	0.0576	25282.3	11532.2
-11.00	0.0548	35413.3	11727.4
-12.00	0.0548	39694.3	11944.0
-13.00	0.0548	42202.2	12089.9
-14.00	0.0548	42375.1	12218.9
-15.00	0.0548	38569.5	12334.2
-16.00	0.0548	31229.7	12348.9
-16.25	0.0548	34538.5	12254.8
-16.50	0.0548	25948.7	11276.7
-16.75	0.0604	19992.8	10639.0
-17.00	0.0604	21826.4	10426.3
-18.00	0.0520	17652.6	10006.1
-19.00	0.4156	12738.1	10027.2
-20.00	0.0100	19041.9	8924.3
-21.00	0.0100	11778.1	9248.6
-22.00	0.0100	19726.2	9074.3

5.6 Z16 ZZ90 x/c=5% suc. x/c=10% press. -

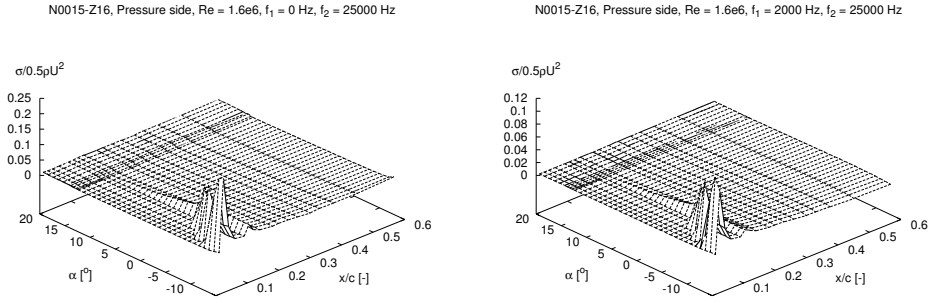

Figure 205: Pressure standard deviations, σ

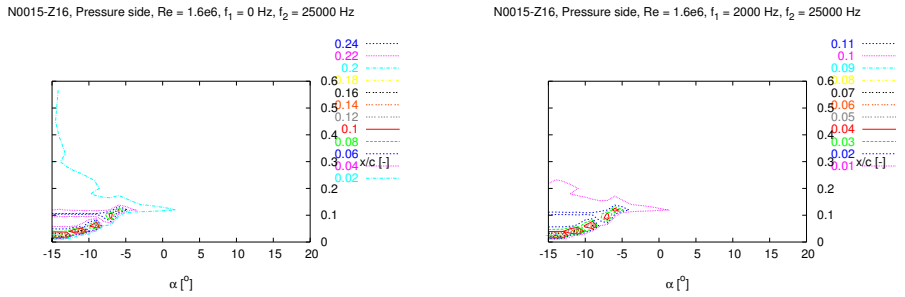

Figure 206: Contours of σ

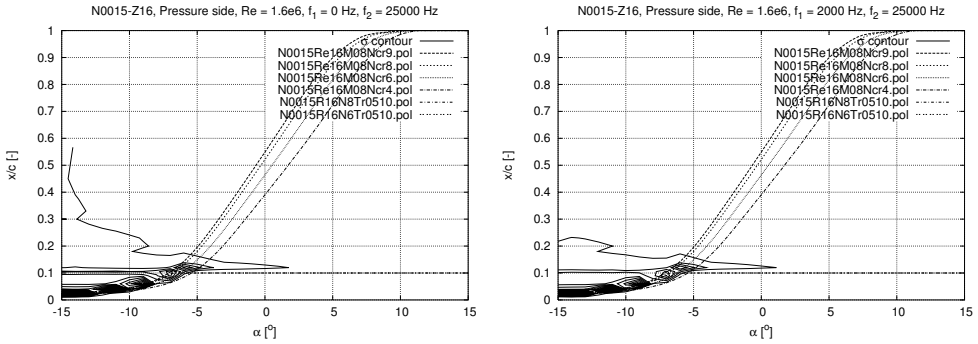

Figure 207: Contours of σ and XFoil data

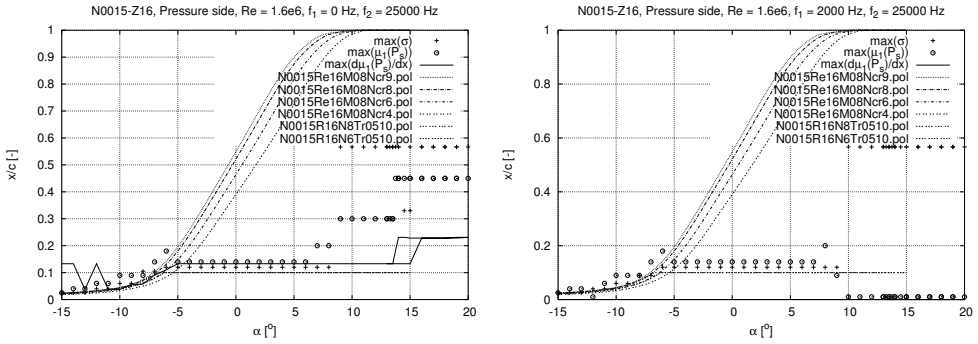

Figure 208: Transition detection

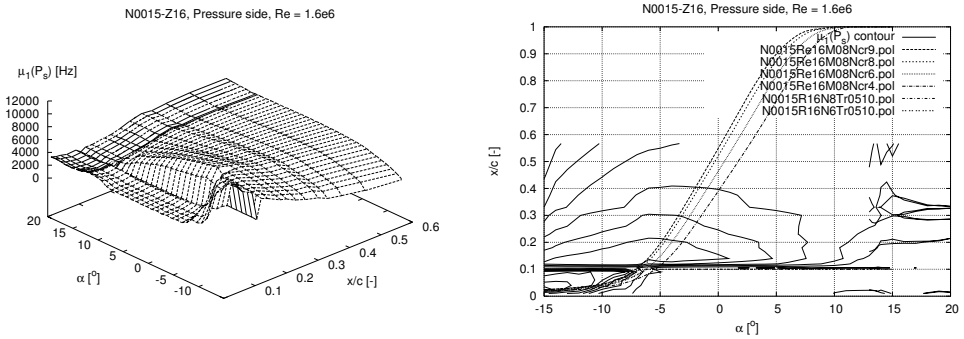

Figure 209: Fourier transform mean, $\mu_1(P_s)$

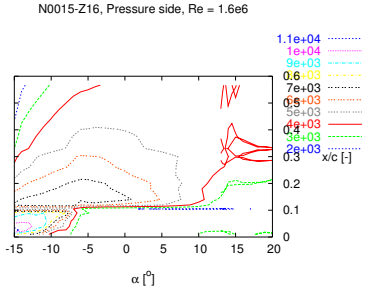

Figure 210: Contours of $\mu_1(P_s)$

```
N0015-Z16
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 13.00  0.1331     17266.1    4073.7
 13.25  0.1331     17313.3    4151.7
 13.50  0.1331     15798.3    4176.1
 13.75  0.1331     14624.9    4203.7
 14.00  0.1331     13680.5    4230.9
 15.00  0.1331     11620.1    4107.0
 16.00  0.2282     11993.9    4159.8
 17.00  0.2282     12578.8    4244.4
 18.00  0.2282     13811.5    4299.8
 19.00  0.2310     14370.9    4340.2
 20.00  0.2310     14983.0    4381.6
 19.00  0.2282     14003.7    4318.9
 18.00  0.2282     14346.8    4279.7
 17.00  0.2282     14175.3    4234.7
 16.00  0.2282     13328.6    4207.4
 15.00  0.2282     12297.1    4120.1
 14.50  0.2310     11925.6    4039.2
 14.00  0.2310     12016.4    4052.3
 13.50  0.1331     16537.9    4235.6
 13.00  0.1331     19232.7    4259.3
 12.00  0.1331     23930.0    4375.1
 11.00  0.1331     31659.3    4506.6
 10.00  0.1331     37644.5    4626.2
  9.00  0.1331     42192.1    4755.2
  8.00  0.1331     48202.1    4918.6
  7.00  0.1331     52826.9    5191.0
  6.00  0.1331     58907.0    5561.1
  5.00  0.1331     63298.5    5891.3
  4.00  0.1331     68373.3    6201.7
  3.00  0.1331     72037.2    6481.8
  2.00  0.1331     76250.4    6728.7
  1.00  0.1331     78713.4    6974.9
  0.00  0.1331     82293.1    7177.6
 -1.00  0.1331     83747.2    7366.6
 -2.00  0.1331     87144.8    7544.5
 -3.00  0.1331     88253.2    7701.0
 -4.00  0.1331     90360.6    7841.5
 -5.00  0.1331     88376.9    7988.7
 -6.00  0.1107     72889.2    7352.2
 -7.00  0.0911     64619.4    7870.0
 -8.00  0.0576     62082.7    7966.5
 -9.00  0.0548     72193.7    8805.3
-10.00  0.0380     79537.8    8913.2
-11.00  0.0380     79266.1    9503.1
-12.00  0.1331     45170.9    9321.5
-13.00  0.0380     43795.2   10398.0
-14.00  0.1331     38971.5   10915.6
-15.00  0.1331     34088.9   11327.0
```

5.7 Z3 ZZ90 x/c=5% suc. x/c=10% press. -

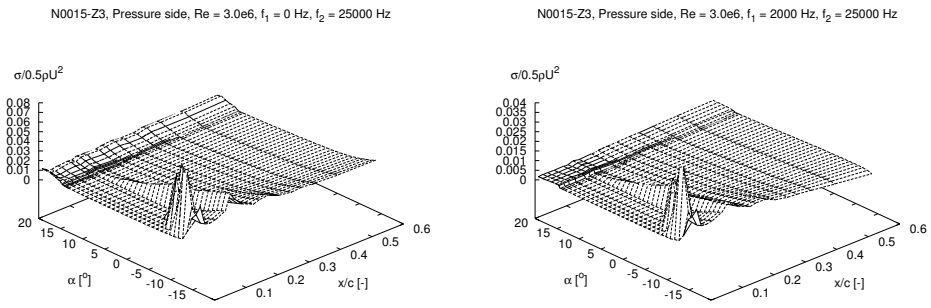

Figure 211: Pressure standard deviations, σ

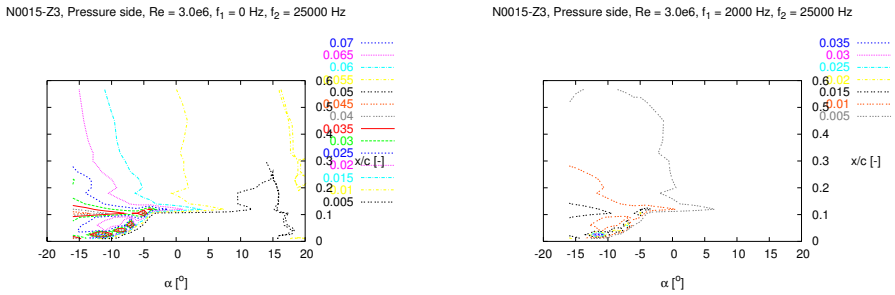

Figure 212: Contours of σ

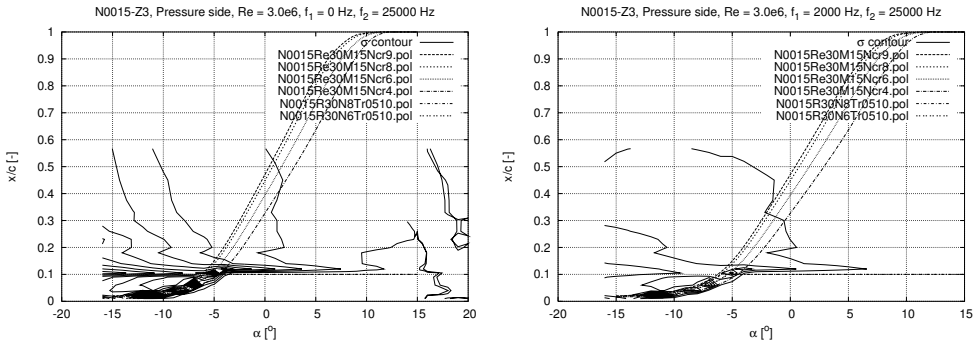

Figure 213: Contours of σ and XFoil data

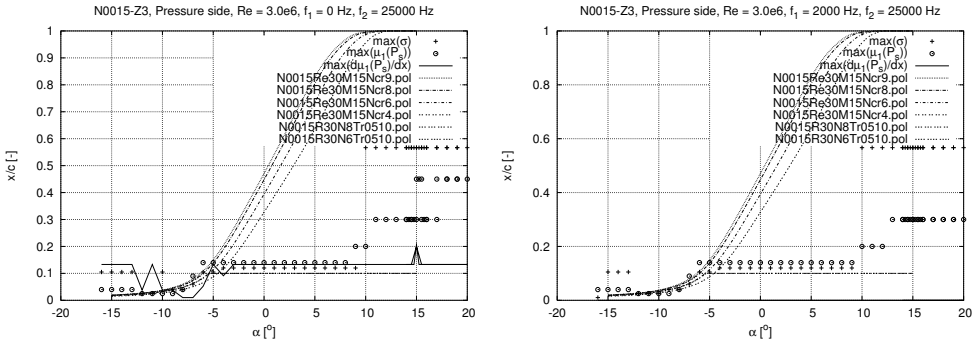

Figure 214: Transition detection

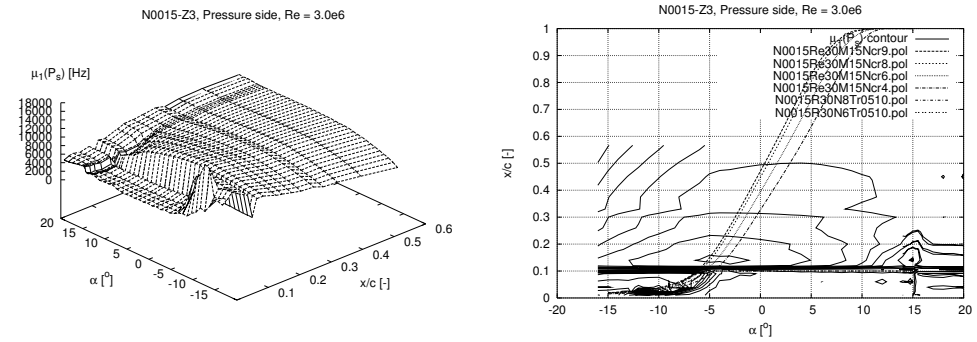

Figure 215: Fourier transform mean, $\mu_1(P_s)$

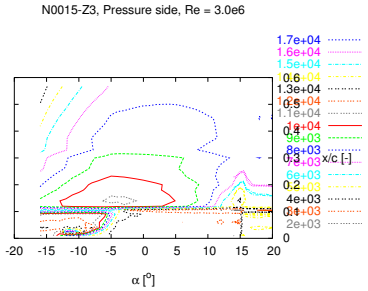

Figure 216: Contours of $\mu_1(P_s)$

```
N0015-Z3
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 14.00  0.1331     50659.9    7730.9
 14.25  0.1331     48840.7    7784.4
 14.50  0.1331     44420.9    7773.0
 14.75  0.1331     41859.6    7743.0
 15.00  0.2058     40327.8    7727.0
 15.25  0.1331     31627.1    7744.1
 15.50  0.1331     31015.6    7747.2
 15.75  0.1331     34996.7    7752.6
 16.00  0.1331     42537.6    7805.2
 17.00  0.1331     47311.0    7883.1
 18.00  0.1331     50806.8    7905.3
 19.00  0.1331     51731.8    7910.0
 20.00  0.1331     53798.5    8018.4
 19.00  0.1331     54219.8    7909.5
 18.00  0.1331     51022.8    8011.1
 17.00  0.1331     50627.1    7958.2
 16.00  0.1331     45055.1    7864.1
 15.50  0.1331     31380.7    7805.7
 15.00  0.2002     40320.0    7793.6
```

14.50	0.1331	44613.2	7844.4
14.00	0.1331	56553.6	7896.3
13.00	0.1331	72290.4	8046.4
12.00	0.1331	83423.7	8185.0
11.00	0.1331	96189.0	8372.3
10.00	0.1331	105668.0	8603.9
9.00	0.1331	110771.7	8892.8
8.00	0.1331	117274.7	9185.1
7.00	0.1331	120070.8	9453.8
6.00	0.1331	123135.2	9731.1
5.00	0.1331	125608.9	9981.7
4.00	0.1331	128614.9	10187.2
3.00	0.1331	129642.4	10380.9
2.00	0.1331	131433.2	10549.0
1.00	0.1331	131711.7	10701.0
0.00	0.1331	133210.5	10840.3
-1.00	0.1331	132862.1	10982.0
-2.00	0.1331	133042.6	11115.1
-3.00	0.1331	122208.7	11236.8
-4.00	0.0911	110698.6	11194.1
-5.00	0.1331	90056.2	11244.0
-6.00	0.0520	89403.6	11033.3
-7.00	0.0100	117371.3	11611.2
-8.00	0.0100	129456.0	13061.8
-9.00	0.0380	106542.1	12916.0
-10.00	0.0380	97714.7	15009.8
-11.00	0.1331	76298.5	17651.4
-12.00	0.0380	78961.3	17117.5
-13.00	0.1331	70283.3	12389.7
-14.00	0.1331	67105.3	12812.8
-15.00	0.1331	61921.9	13064.3
-16.00	0.1331	57074.0	13060.7

5.8 Z6 ZZ90 x/c=5% suc. x/c=10% press. -

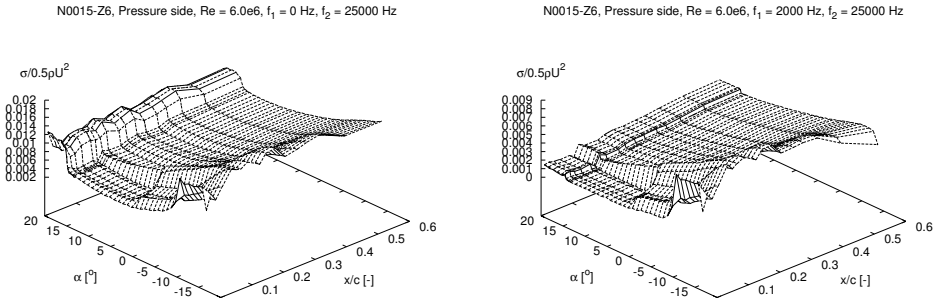

Figure 217: Pressure standard deviations, σ

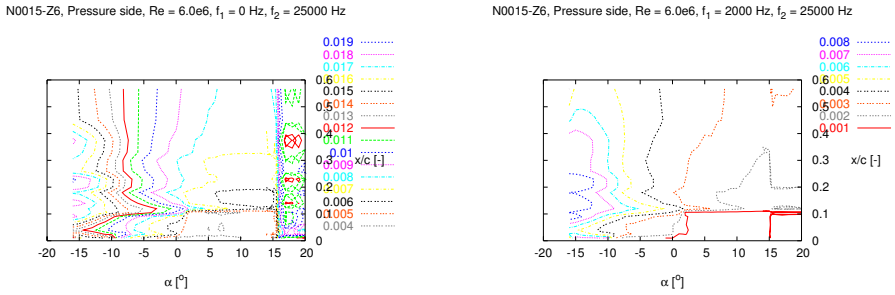

Figure 218: Contours of σ

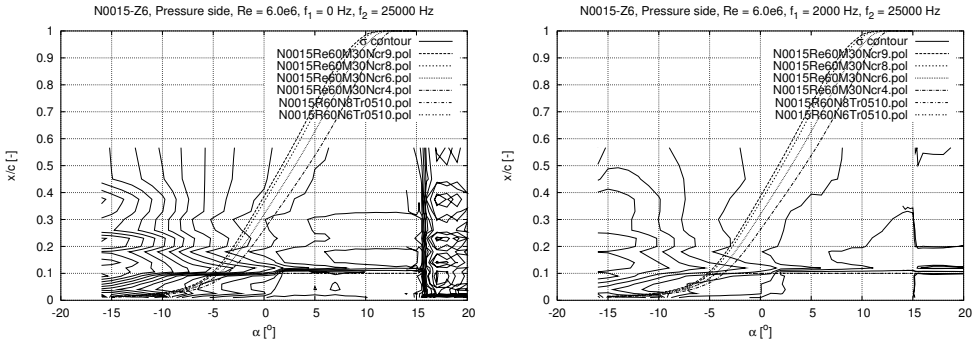

Figure 219: Contours of σ and XFoil data

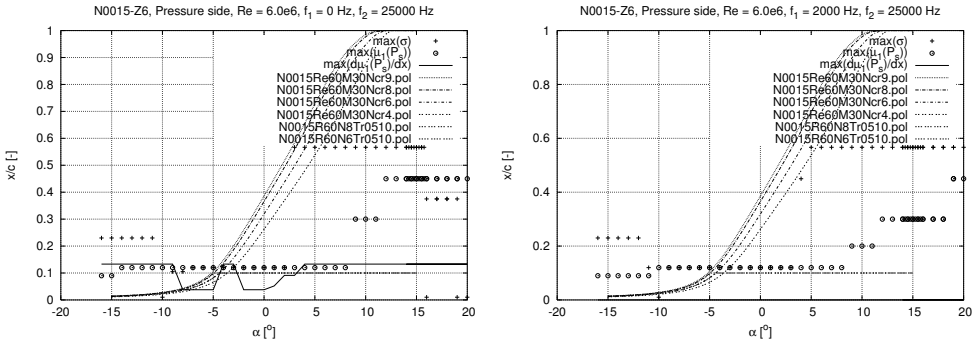

Figure 220: Transition detection

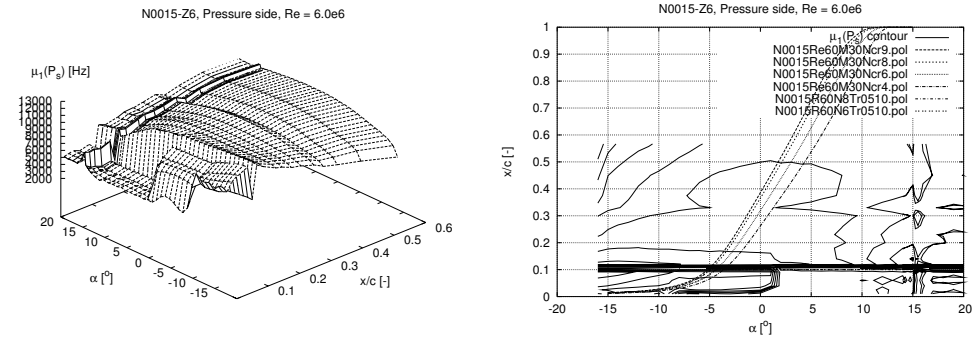

Figure 221: Fourier transform mean, $\mu_1(P_s)$

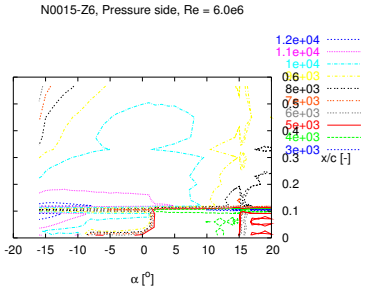

Figure 222: Contours of $\mu_1(P_s)$

```
N0015-Z6
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
14.00	0.1331	86855.8	9348.9
14.25	0.1331	85002.6	9308.8
14.50	0.1331	82786.2	9256.4
14.75	0.1331	81786.0	9215.6
15.00	0.1331	79053.3	9158.2
15.25	0.1331	73220.2	9632.0
15.50	0.1331	74451.5	9575.5
15.75	0.1331	77086.6	9517.0
16.00	0.1331	79020.6	9327.7
17.00	0.1331	81837.1	8954.7
18.00	0.1331	78912.6	8960.4
19.00	0.1331	77153.3	8890.0
20.00	0.1331	74240.4	9004.9
19.00	0.1331	75572.1	8958.1
18.00	0.1331	79813.6	8954.9
17.00	0.1331	79968.6	8991.0
16.00	0.1331	79217.4	9169.9
15.50	0.1331	73381.7	9557.3
15.00	0.1331	79456.1	9160.6
14.50	0.1331	82050.7	9267.7
14.00	0.1331	86379.8	9306.8
13.00	0.1331	91988.1	9452.1
12.00	0.1331	98672.9	9537.5
11.00	0.1331	102782.0	9722.6
10.00	0.1331	106887.5	9917.0
9.00	0.1331	108317.7	10074.2
8.00	0.1331	112822.7	10401.9
7.00	0.1331	116713.1	10671.2
6.00	0.1331	120796.0	10784.8
5.00	0.1331	122252.2	10972.3
4.00	0.1331	121788.0	11135.6
3.00	0.0911	117690.8	11210.4
2.00	0.0911	119656.6	11231.8
1.00	0.0520	99324.8	11589.7
0.00	0.0380	93535.3	11582.7
-1.00	0.0380	83709.6	11616.9
-2.00	0.0380	72108.5	11670.1
-3.00	0.1331	69684.5	11698.5
-4.00	0.1331	69403.9	11747.4
-5.00	0.0380	74917.1	11813.3
-6.00	0.0380	84788.8	11885.8
-7.00	0.0380	90194.9	11945.3
-8.00	0.0380	72037.6	12010.4
-9.00	0.1331	69014.1	12083.6
-10.00	0.1331	68239.3	12125.7
-11.00	0.1331	67515.3	12203.2
-12.00	0.1331	66675.3	12260.8
-13.00	0.1331	65267.5	12298.7
-14.00	0.1331	64232.6	12357.0
-15.00	0.1331	62412.8	12424.8
-16.00	0.1331	59799.8	12429.7

5.9 T16 Trip wire. Bump tape 2% -

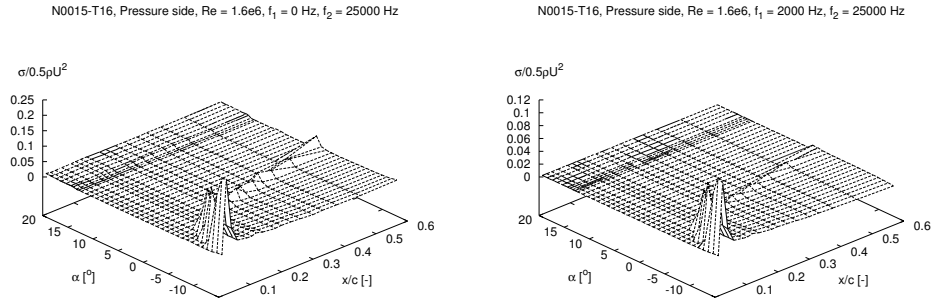

Figure 223: Pressure standard deviations, σ

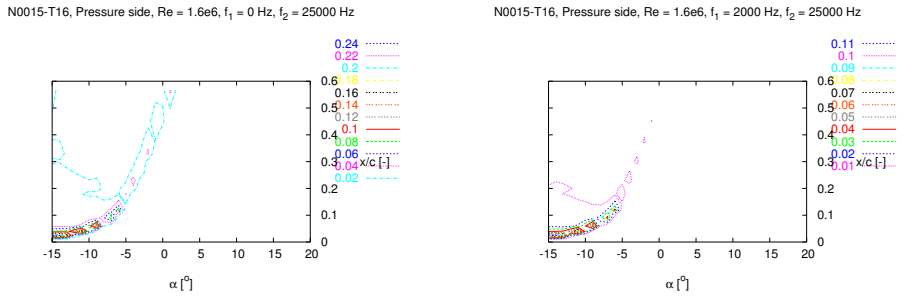

Figure 224: Contours of σ

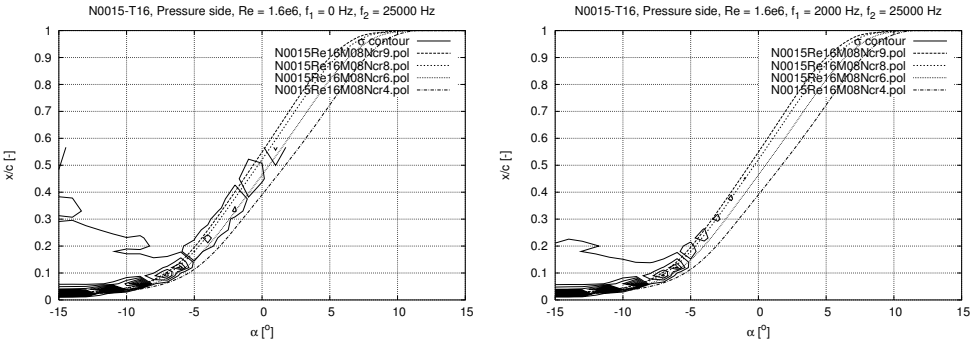

Figure 225: Contours of σ and XFoil data

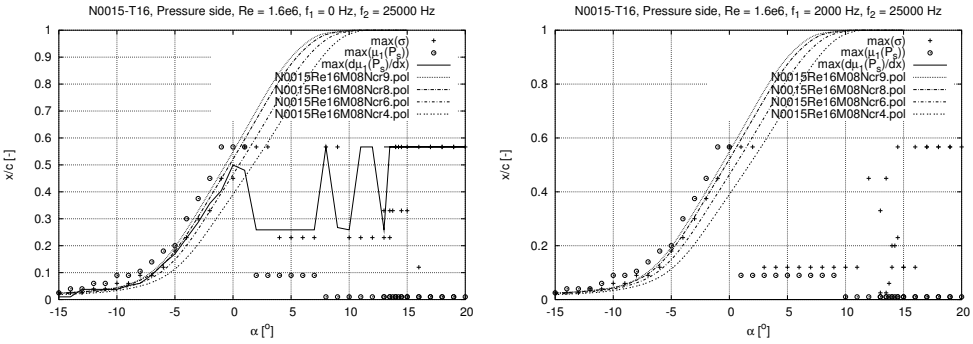

Figure 226: Transition detection

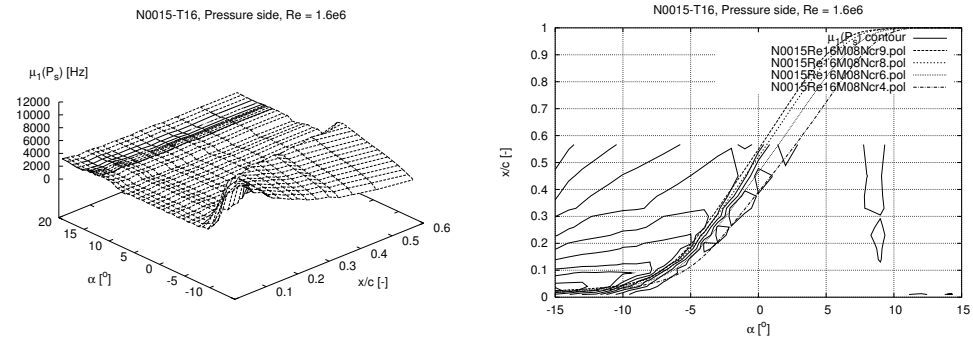

Figure 227: Fourier transform mean, $\mu_1(P_s)$

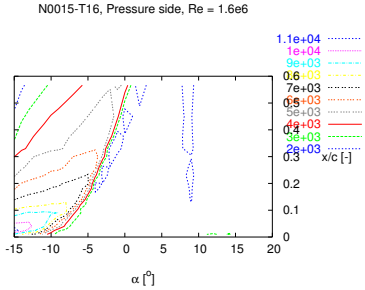

Figure 228: Contours of $\mu_1(P_s)$

```
N0015-T16
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 13.00  0.5667      2347.3    2963.2
 13.50  0.5667      2192.8    2822.8
 13.75  0.5667      2313.8    2945.5
 14.00  0.5667      2244.3    3026.9
 14.25  0.5667      2328.3    3092.3
 14.50  0.5667      2283.7    2816.7
 15.00  0.5667      2296.4    2971.9
 16.00  0.5667      2158.3    2662.9
 17.00  0.5667      2187.6    2667.8
 18.00  0.5667      2204.3    2768.3
 19.00  0.5667      2235.3    2899.3
 20.00  0.5667      2271.6    2958.2
 19.00  0.5667      2254.5    2873.3
 18.00  0.5667      2210.2    2761.4
 17.00  0.5667      2170.7    2726.5
 16.00  0.5667      2154.5    2715.3
 15.00  0.5667      2289.2    2989.1
 14.50  0.5667      2332.9    2975.5
 14.00  0.5667      2291.6    3041.8
 13.50  0.5667      2362.1    2956.5
 13.00  0.2590      2289.5    2922.8
 12.00  0.5667      2394.9    3064.7
 11.00  0.5667      2277.0    2991.1
 10.00  0.2590      2405.9    2840.8
  9.00  0.2674      2354.7    2374.0
  8.00  0.5667      1960.4    2326.3
  7.00  0.2590      2308.2    2288.4
  6.00  0.2590      2615.0    2442.9
  5.00  0.2590      2345.0    2337.1
  4.00  0.2590      2628.2    2456.3
  3.00  0.2590      2336.8    2357.0
  2.00  0.2590      2527.6    2424.9
  1.00  0.4799      5238.8    2600.7
  0.00  0.4995     32722.3    4909.5
 -1.00  0.4044     42803.4    5101.0
 -2.00  0.3569     55470.0    5648.2
 -3.00  0.2869     61920.7    5965.6
 -4.00  0.2282     74896.0    6579.6
 -5.00  0.1694     79450.6    7200.9
 -6.00  0.1331     68977.6    7452.5
 -7.00  0.0911     73027.9    7864.8
 -8.00  0.0604     83196.0    8305.2
 -9.00  0.0520     88626.6    8941.7
-10.00  0.0380     87254.4    9103.3
-11.00  0.0380     84206.7    9579.2
-12.00  0.0380     42270.1    9324.5
-13.00  0.0380     45602.9   10509.4
-14.00  0.0100     26013.5   10895.0
-15.00  0.0100     10565.7   11288.6
```

5.10 T3 Trip wire. Bump tape 2% -

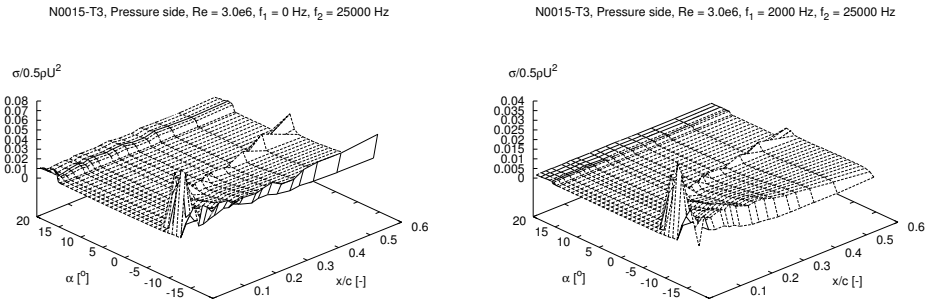

Figure 229: Pressure standard deviations, σ

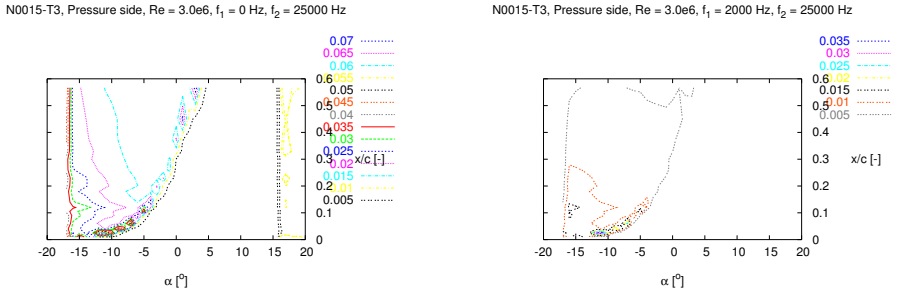

Figure 230: Contours of σ

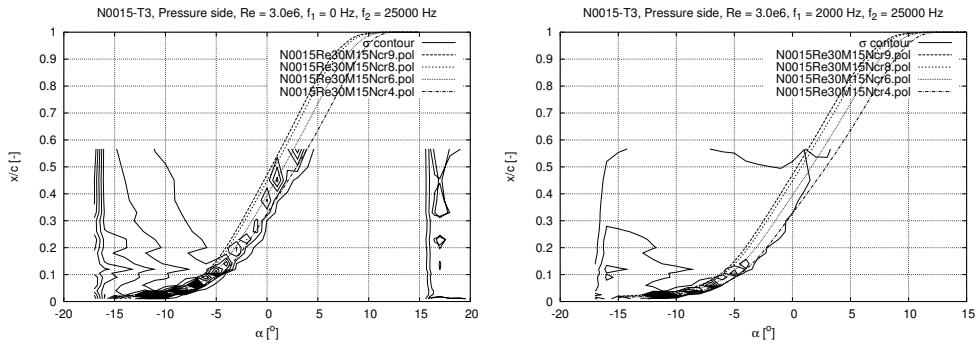

Figure 231: Contours of σ and XFoil data

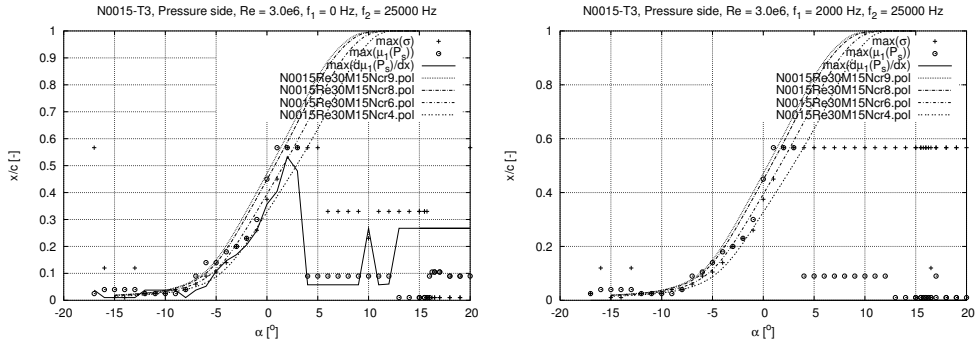

Figure 232: Transition detection

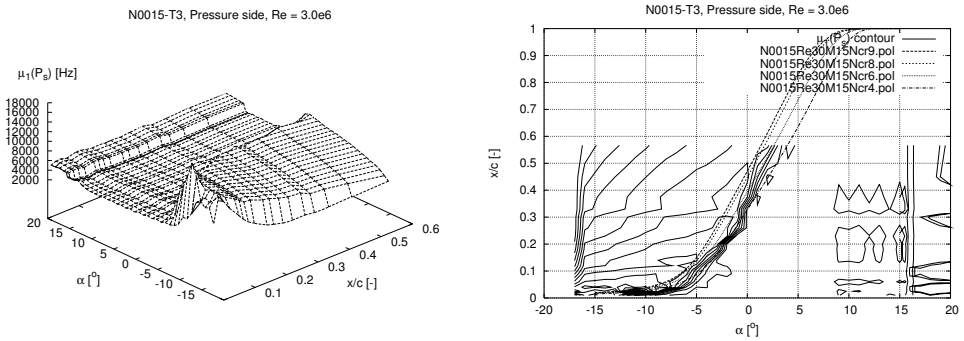

Figure 233: Fourier transform mean, $\mu_1(P_s)$

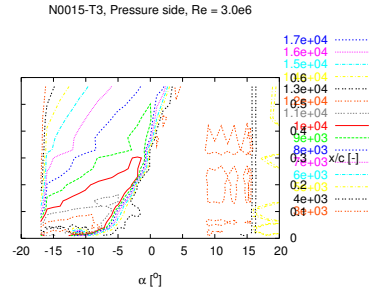

Figure 234: Contours of $\mu_1(P_s)$

```
N0015-T3
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 15.00  0.2674      3759.7    3982.1
 15.50  0.2674      3676.9    3857.2
 15.75  0.2674      3820.6    3882.8
 16.00  0.2674      4348.9    3837.4
 16.25  0.2674      4717.0    3933.3
 16.50  0.2674      5140.6    5120.3
 17.00  0.2674      5411.5    5074.6
 18.00  0.2674      5561.3    5256.3
 19.00  0.2674      6289.6    5315.9
 20.00  0.2674      6331.2    5423.0
 19.00  0.2674      6236.8    5400.0
 18.00  0.2674      5931.0    5338.2
 17.00  0.2674      5576.0    5217.0
 16.50  0.2674      5383.6    5162.0
 16.00  0.2674      5379.8    5131.8
 15.50  0.2674      3951.3    3856.0
 15.00  0.2674      3416.4    3860.1
 14.00  0.2674      3806.7    4182.1
 13.00  0.2674      3459.0    3565.9
```

12.00	0.0604	3967.9	3391.8
11.00	0.0576	3796.5	3257.7
10.00	0.2674	4565.8	3309.2
9.00	0.0576	4330.1	3264.1
8.00	0.0576	5285.3	3593.9
7.00	0.0576	4576.6	3424.5
6.00	0.0576	5067.7	3641.9
5.00	0.0576	4490.9	3473.6
4.00	0.0576	5476.1	3736.6
3.00	0.4799	14632.2	4997.1
2.00	0.5331	49445.5	8402.6
1.00	0.4044	44509.1	8759.6
0.00	0.3569	77587.5	9395.7
-1.00	0.2590	101497.2	9924.8
-2.00	0.2058	112854.7	10260.7
-3.00	0.1694	112374.2	10733.6
-4.00	0.1471	90283.9	10901.2
-5.00	0.1079	83602.2	11234.6
-6.00	0.0520	94826.8	11212.4
-7.00	0.0380	118767.4	11783.9
-8.00	0.0100	140876.0	12381.9
-9.00	0.0380	124330.5	12188.9
-10.00	0.0380	95162.6	14808.0
-11.00	0.0380	92982.5	17996.3
-12.00	0.0380	68420.9	15423.7
-13.00	0.0100	45168.4	12795.9
-14.00	0.0100	31584.6	13273.6
-15.00	0.0100	41502.0	13022.7
-16.00	0.0100	31487.1	13322.1
-17.00	0.0380	19910.5	13569.5

5.11 T6 Trip wire. Bump tape 2% -

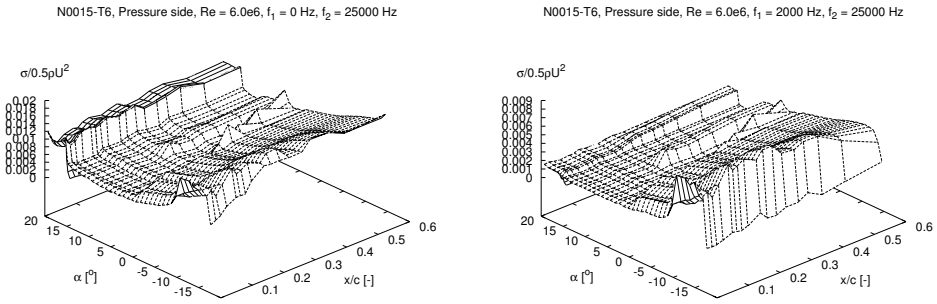

Figure 235: Pressure standard deviations, σ

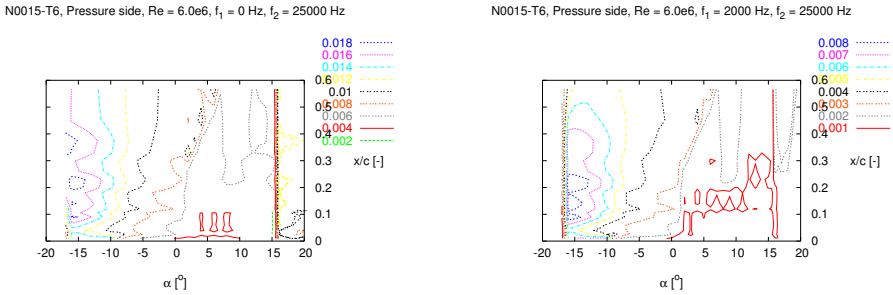

Figure 236: Contours of σ

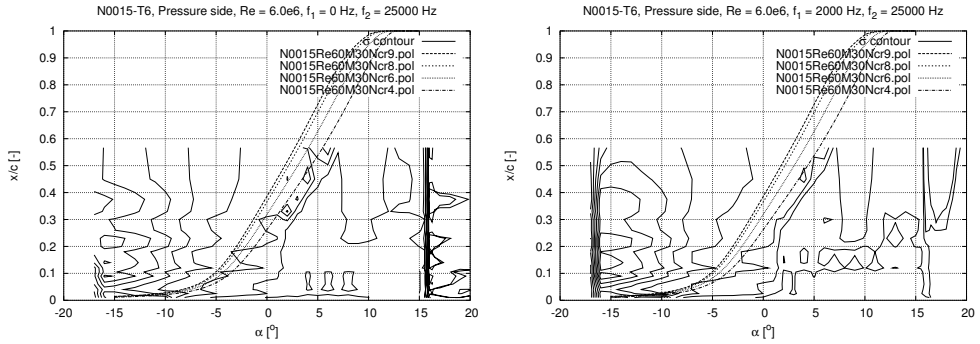

Figure 237: Contours of σ and XFoil data

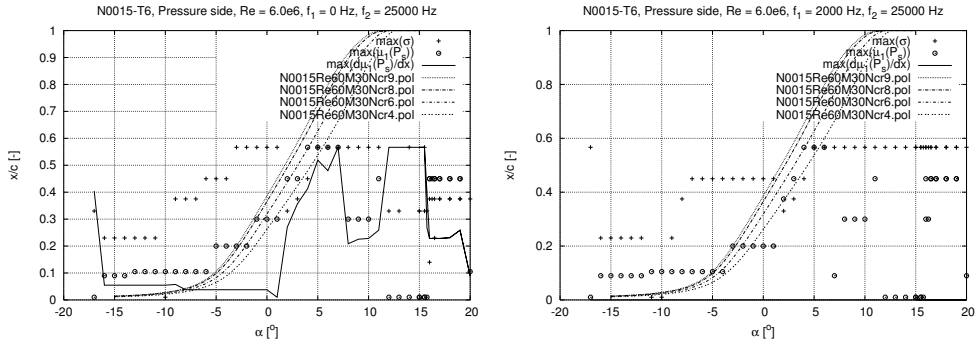

Figure 238: Transition detection

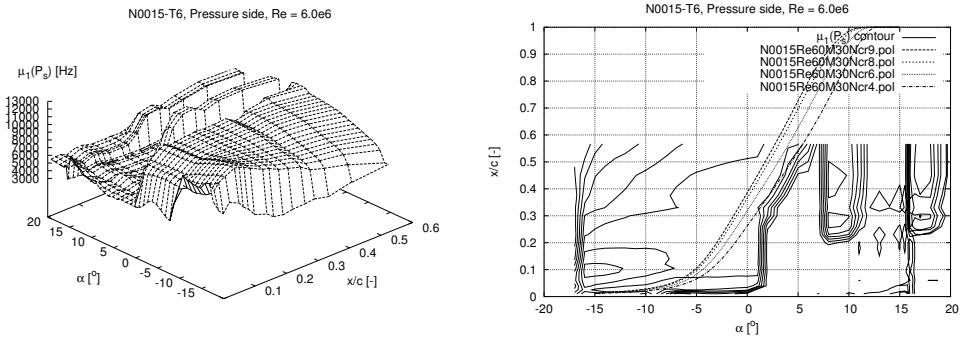

Figure 239: Fourier transform mean, $\mu_1(P_s)$

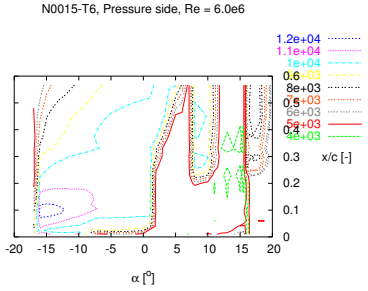

Figure 240: Contours of $\mu_1(P_s)$

N0015-T6
alpha [degrees] angle of attack
xtr* [-] transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx* [Hz/-] d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1) [Hz] max mu1 of all chordwise positions

alpha	xtr*	d(mu1)/dx*	max(mu1)
15.00	0.5667	4315.1	6392.3
15.50	0.5667	4024.0	6560.8
15.75	0.2674	4595.8	6571.1
16.00	0.2282	43038.3	6924.7
16.25	0.2282	49917.6	7741.8
16.50	0.2282	37077.1	8101.8
17.00	0.2282	43181.8	8542.3
18.00	0.2310	34569.5	8196.6
19.00	0.2590	15857.8	6690.3
20.00	0.0883	5619.8	5571.4
19.00	0.2590	19470.3	7069.7
18.00	0.2310	42411.8	8669.5
17.00	0.2282	43726.9	8640.8
16.50	0.2282	42880.7	8491.8
16.00	0.2282	48395.5	8658.9
15.50	0.5667	4281.1	6820.8
15.00	0.5667	4034.4	6647.2
14.00	0.5667	4252.7	5974.5
13.00	0.5667	4107.3	5294.4
12.00	0.5667	4304.0	5160.9
11.00	0.2590	44877.7	7736.9
10.00	0.2282	94202.1	10014.5
9.00	0.2254	85253.3	10158.7
8.00	0.2086	85673.7	10328.1
7.00	0.5667	4506.4	4514.8
6.00	0.4799	27069.7	7750.6
5.00	0.5191	46147.8	10101.4
4.00	0.4128	49577.3	10251.6
3.00	0.3569	61270.4	10543.2
2.00	0.2702	53498.2	10764.9
1.00	0.0100	103020.5	10855.6
0.00	0.0380	92517.1	10909.6
-1.00	0.0380	84046.8	10909.6
-2.00	0.0380	71946.4	10906.6
-3.00	0.0380	67762.8	10937.2
-4.00	0.0380	69500.5	10909.1
-5.00	0.0380	79487.8	10932.6
-6.00	0.0380	87739.4	10934.4
-7.00	0.0380	92608.9	10948.8
-8.00	0.0380	54020.8	11195.0
-9.00	0.0576	27340.6	11400.5
-10.00	0.0548	32928.6	11638.7
-11.00	0.0548	38386.4	11770.9
-12.00	0.0548	41890.4	11962.4
-13.00	0.0548	42948.0	12106.8
-14.00	0.0548	43437.6	12291.8
-15.00	0.0548	39363.1	12359.3
-16.00	0.0548	28840.4	12372.8
-17.00	0.4044	8381.0	9498.5

5.12 C16a Clean 200x200

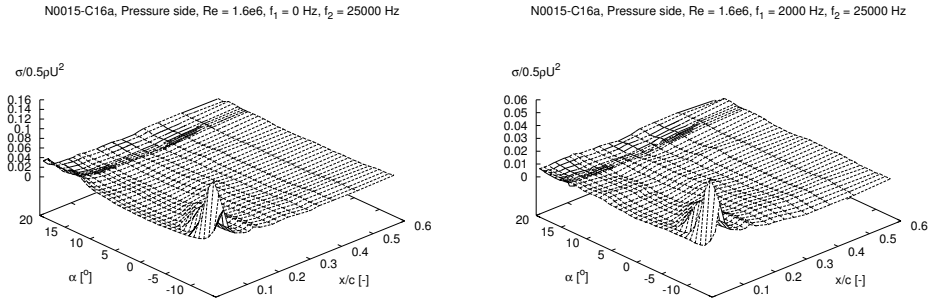

Figure 241: Pressure standard deviations, σ

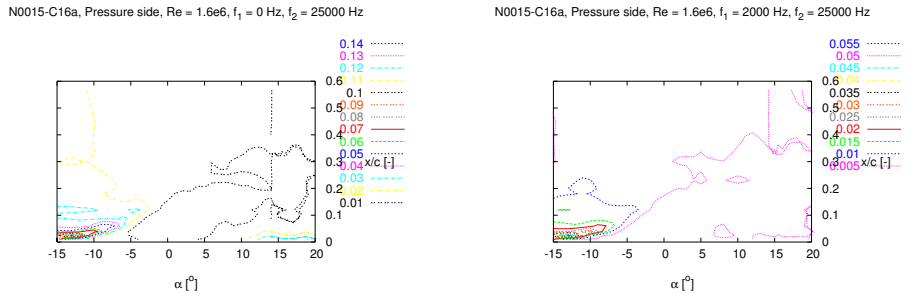

Figure 242: Contours of σ

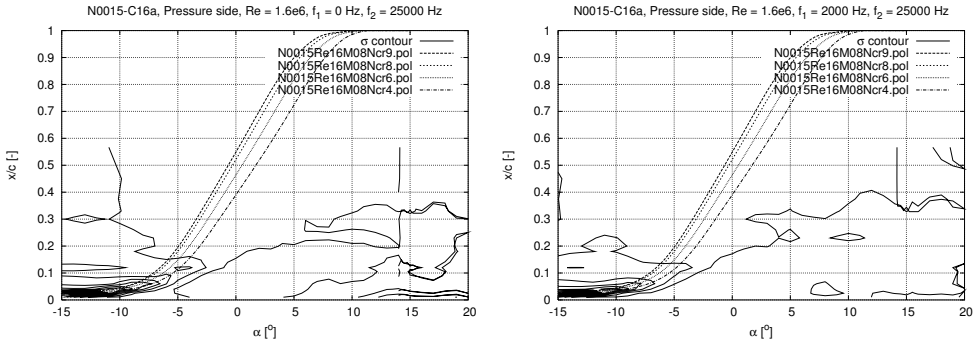

Figure 243: Contours of σ and XFoil data

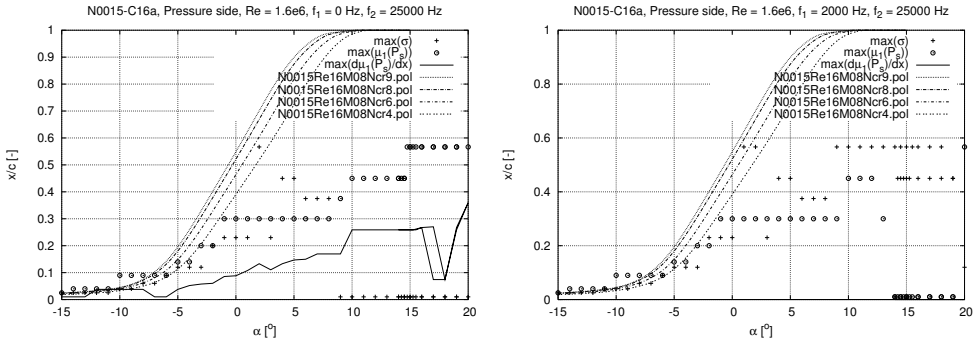

Figure 244: Transition detection

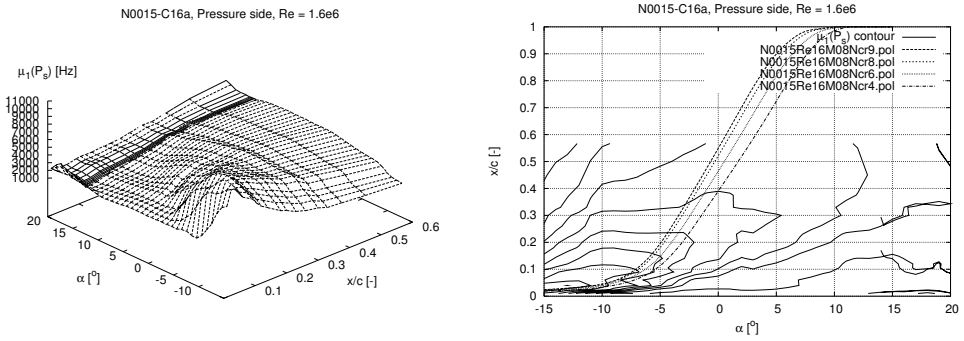

Figure 245: Fourier transform mean, $\mu_1(P_s)$

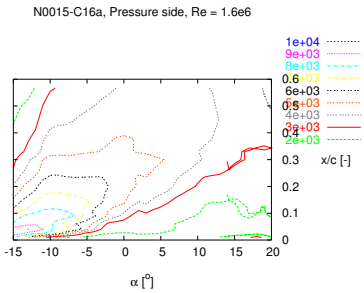

Figure 246: Contours of $\mu_1(P_s)$

N0015-C16a
alpha [degrees] angle of attack
xtr* [-] transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx* [Hz/-] d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1) [Hz] max mu1 of all chordwise positions

alpha	xtr*	d(mu1)/dx*	max(mu1)
14.00	0.2590	9907.7	3643.5
14.25	0.2590	11127.6	3753.7
14.50	0.2590	11032.3	3699.2
14.75	0.2590	10362.2	3673.2
15.00	0.2590	10130.7	3681.7
15.25	0.2590	9264.2	3663.6
16.00	0.2674	8148.2	3674.1
17.00	0.0743	8080.3	3669.0
18.00	0.0743	7333.9	3730.2
19.00	0.2674	7766.4	4078.2
20.00	0.3597	8255.2	4344.6
19.00	0.2590	8245.0	4076.0
18.00	0.0743	7411.1	3619.0
17.00	0.2702	7335.2	3587.9
16.00	0.2674	8739.6	3586.0
15.50	0.2590	9520.3	3608.1
15.00	0.2590	10371.0	3598.7
14.50	0.2590	11021.8	3636.4
14.00	0.2590	11295.0	3724.2
13.00	0.2590	12336.0	3969.3
12.00	0.2590	13072.4	4175.7
11.00	0.2590	14237.9	4277.8
10.00	0.2590	14320.0	4367.6
9.00	0.1694	16251.9	4422.2
8.00	0.1694	18741.5	4537.0
7.00	0.1694	20910.9	4740.5
6.00	0.1499	21058.4	4910.3
5.00	0.1471	21579.2	5064.1
4.00	0.1331	23533.8	5172.0
3.00	0.1107	26203.4	5396.8
2.00	0.1331	25953.3	5396.6
1.00	0.1079	29680.4	5537.6
0.00	0.0883	37327.6	5717.3
-1.00	0.0855	39252.5	5753.1
-2.00	0.0604	43108.3	5967.8
-3.00	0.0576	53379.7	6376.2
-4.00	0.0520	58515.1	6620.4
-5.00	0.0380	68389.1	7091.1
-6.00	0.0100	77390.5	7360.8
-7.00	0.0100	83547.8	8130.9
-8.00	0.0380	93027.3	8558.2
-9.00	0.0380	101305.1	8805.2
-10.00	0.0380	102044.8	8936.4
-11.00	0.0380	90904.2	8991.0
-12.00	0.0380	70905.1	9748.3
-13.00	0.0100	51524.6	10004.6
-14.00	0.0100	28114.4	9820.8
-15.00	0.0100	12814.7	9653.0

5.13 C3a Clean 200x200

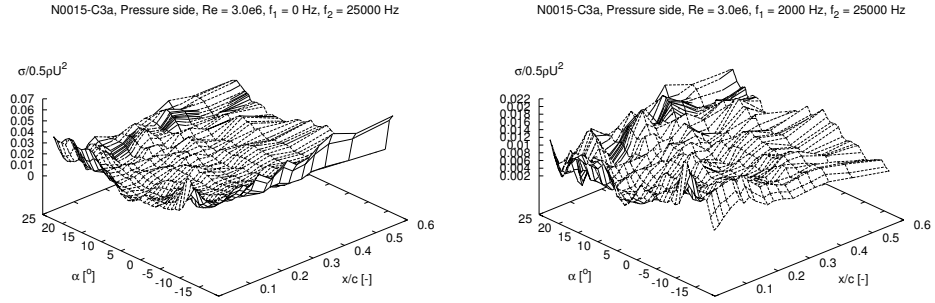

Figure 247: Pressure standard deviations, σ

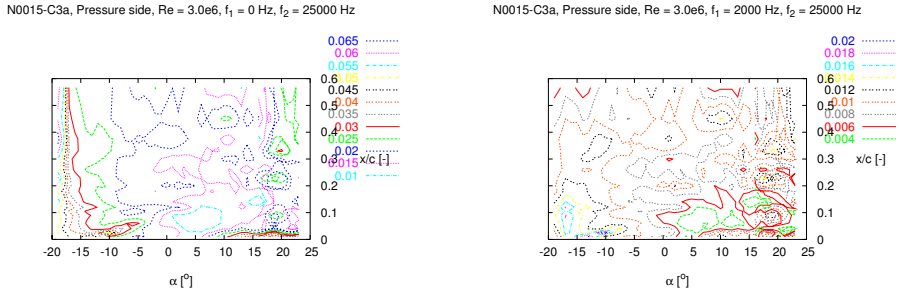

Figure 248: Contours of σ

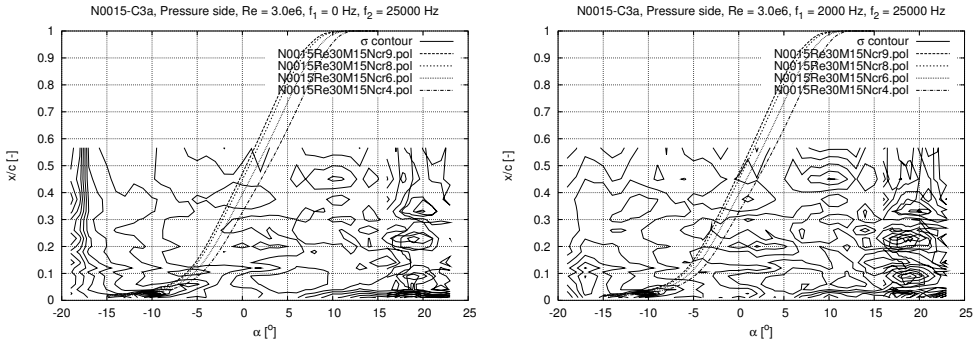

Figure 249: Contours of σ and XFoil data

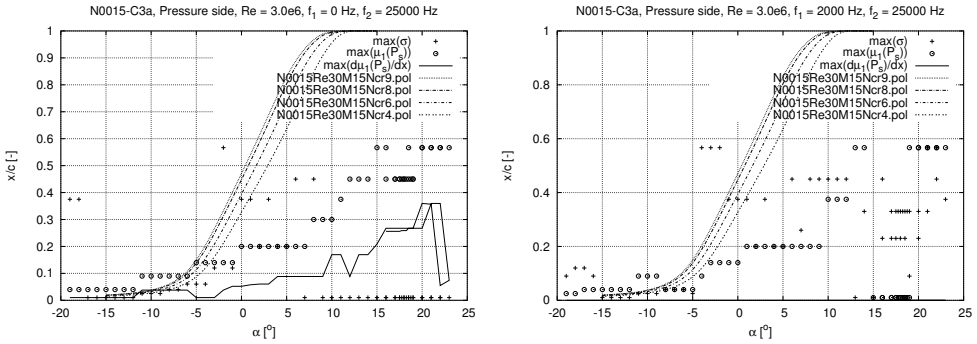

Figure 250: Transition detection

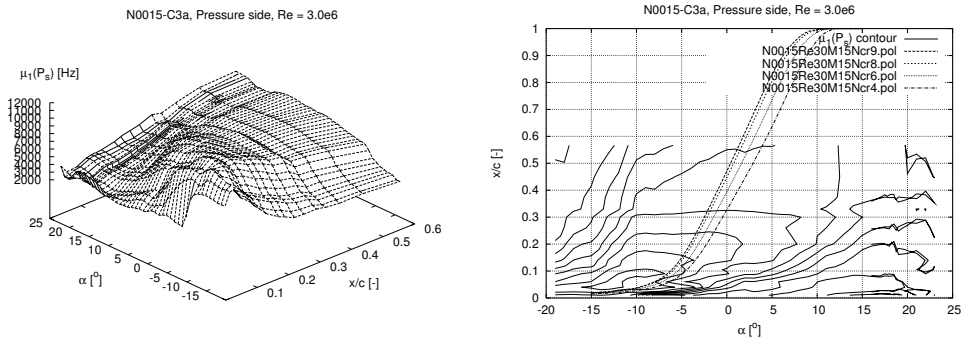

Figure 251: Fourier transform mean, $\mu_1(P_s)$

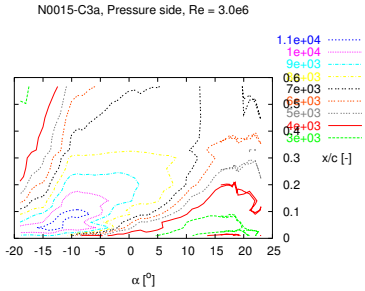

Figure 252: Contours of $\mu_1(P_s)$

```
N0015-C3a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.2562     17636.9    6468.8
 17.00  0.2562     18378.7    6450.8
 17.50  0.2562     18267.5    6387.7
 17.75  0.2590     17813.3    6511.6
 18.00  0.2590     17362.6    6509.7
 18.25  0.2590     18666.6    6550.3
 18.50  0.2674     18004.1    6507.2
 18.75  0.2674     17325.6    6740.0
 19.00  0.2674     17170.5    6718.0
 20.00  0.3597     17683.9    7093.6
 21.00  0.3569     18193.6    7049.4
 22.00  0.0548     16264.3    7175.8
 23.00  0.0743     15107.8    7241.3
 22.00  0.3597     16870.0    7206.3
 21.00  0.3597     17574.5    7115.0
 20.00  0.2674     17011.9    7079.0
 19.00  0.2674     18409.1    6811.6
 18.50  0.2674     19472.5    6632.3
 18.00  0.2674     18493.8    6493.5
```

17.50	0.2674	18545.6	6501.8
17.00	0.2674	18676.2	6512.0
16.00	0.2674	18139.3	6502.9
15.00	0.2086	18361.0	6496.4
14.00	0.1694	20542.2	6560.2
13.00	0.1694	24278.6	6891.5
12.00	0.0883	25284.1	7106.1
11.00	0.1694	28663.6	7469.8
10.00	0.1694	28676.6	7625.4
9.00	0.0883	34517.9	7840.3
8.00	0.0883	40363.3	8028.8
7.00	0.0883	45340.8	8270.5
6.00	0.0883	50339.3	8440.2
5.00	0.0883	51046.5	8612.2
4.00	0.0883	49266.1	8776.7
3.00	0.0604	49828.2	8950.9
2.00	0.0604	54353.5	8936.5
1.00	0.0576	59409.7	9205.3
0.00	0.0520	61487.3	9315.1
-1.00	0.0520	61147.9	9414.0
-2.00	0.0380	68951.9	9631.2
-3.00	0.0100	80377.7	9903.2
-4.00	0.0100	84576.1	10048.9
-5.00	0.0100	84235.0	10253.6
-6.00	0.0380	94481.0	10636.1
-7.00	0.0380	104174.5	11035.0
-8.00	0.0380	116998.9	11233.6
-9.00	0.0380	97033.4	11412.8
-10.00	0.0380	56736.5	11286.7
-11.00	0.0380	44979.9	11237.4
-12.00	0.0100	47096.4	11254.8
-13.00	0.0100	42754.9	11662.5
-14.00	0.0100	35347.7	11604.1
-15.00	0.0100	29670.9	11188.2
-16.00	0.0100	27898.6	11013.9
-17.00	0.0100	26632.0	10864.1
-18.00	0.0100	22148.5	10769.1
-19.00	0.0100	14136.4	10455.3

5.14 C6a Clean 200x200

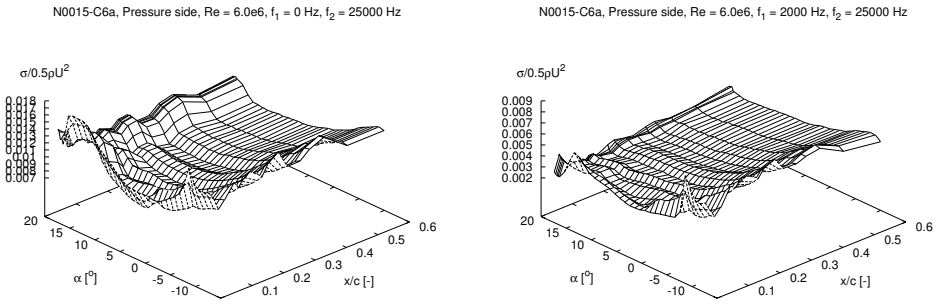

Figure 253: Pressure standard deviations, σ

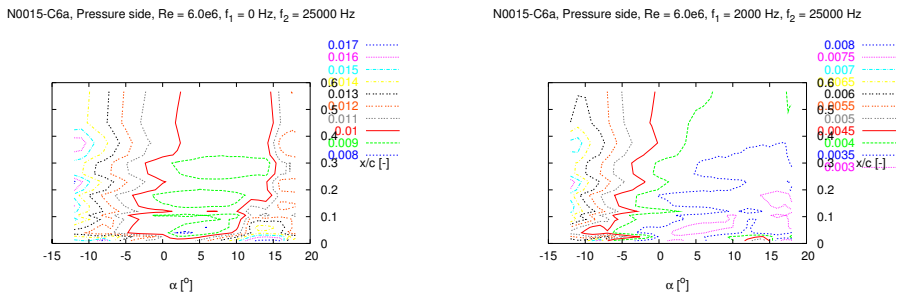

Figure 254: Contours of σ

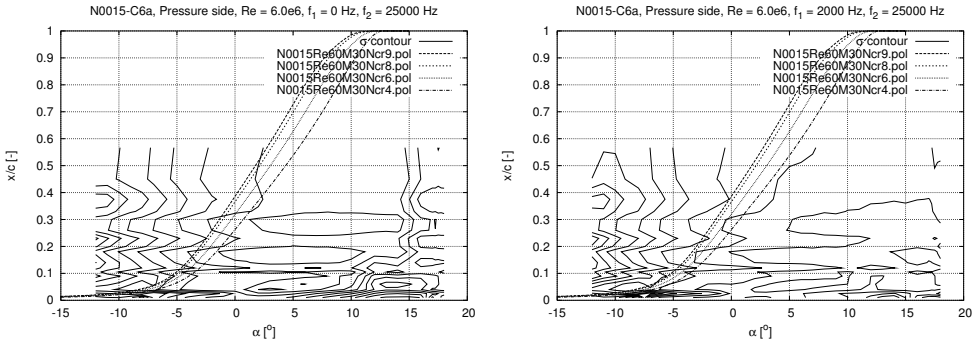

Figure 255: Contours of σ and XFoil data

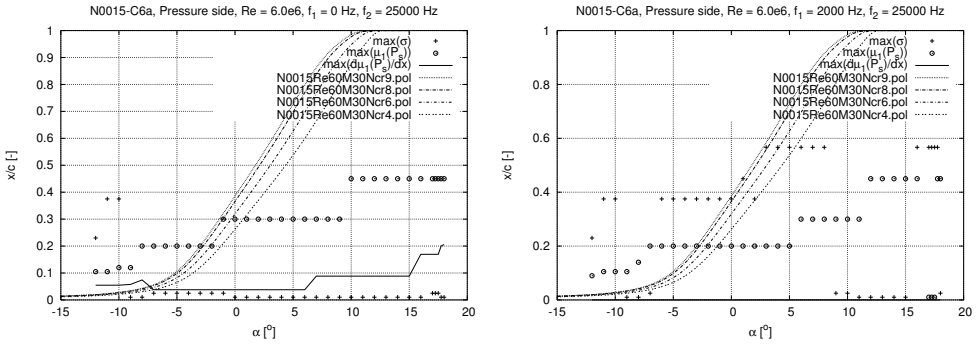

Figure 256: Transition detection

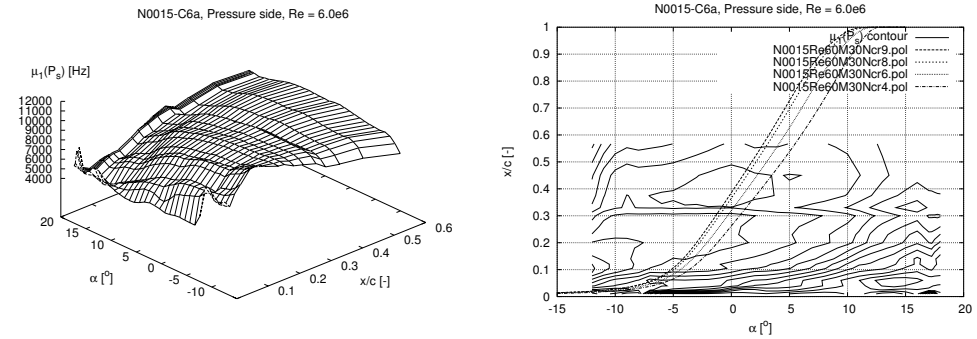

Figure 257: Fourier transform mean, $\mu_1(P_s)$

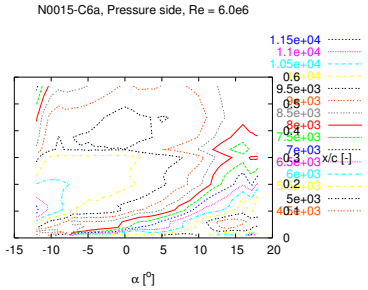

Figure 258: Contours of $\mu_1(P_s)$

```
N0015-C6a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.0548     46201.4   11600.9
-11.00  0.0548     39872.4   11153.2
-10.00  0.0548     35052.6   10862.7
 -9.00  0.0576     29624.2   10650.6
 -8.00  0.0743     26121.1   10534.6
 -7.00  0.0380     37489.5   10449.3
 -6.00  0.0380     59311.9   10438.9
 -5.00  0.0380     57774.1   10361.5
 -4.00  0.0380     58034.2   10353.0
 -3.00  0.0380     56419.6   10281.2
 -2.00  0.0380     56721.7   10271.6
 -1.00  0.0380     56033.6   10203.8
  0.00  0.0380     52274.3   10209.8
  1.00  0.0380     44895.7   10121.1
  2.00  0.0380     39739.8   10003.1
  3.00  0.0380     37893.8    9935.1
  4.00  0.0380     37677.6    9814.0
  5.00  0.0380     37734.2    9782.2
  6.00  0.0380     36100.2    9691.5
  7.00  0.0883     31428.1    9594.7
  8.00  0.0883     30727.4    9475.6
  9.00  0.0883     29233.5    9321.0
 10.00  0.0883     27079.2    9230.9
 11.00  0.0883     25802.3    9019.7
 12.00  0.0883     30827.8    8826.2
 13.00  0.0883     33521.2    8611.0
 14.00  0.0883     32701.2    8417.2
 15.00  0.0883     25415.6    8340.4
 16.00  0.1694     19635.0    8186.0
 17.00  0.1694     20666.3    8374.3
 17.25  0.1694     20462.0    8377.5
 17.50  0.1694     20898.9    8394.3
 17.75  0.2002     20425.6    8424.0
 18.00  0.2058     21022.2    8455.5
```

5.15 Z16a ZZ90 x/c=5% suc. x/c=10% press. 200x200

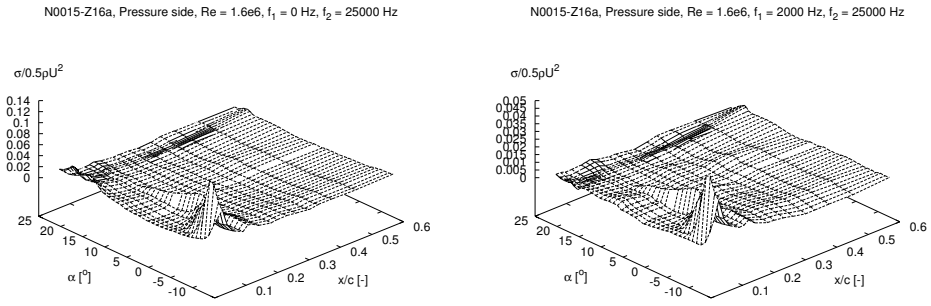

Figure 259: Pressure standard deviations, σ

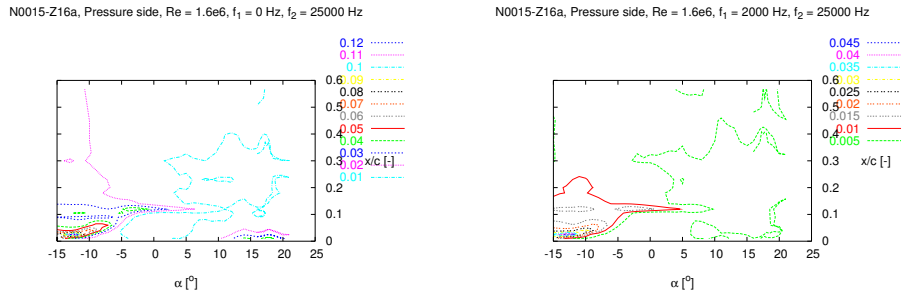

Figure 260: Contours of σ

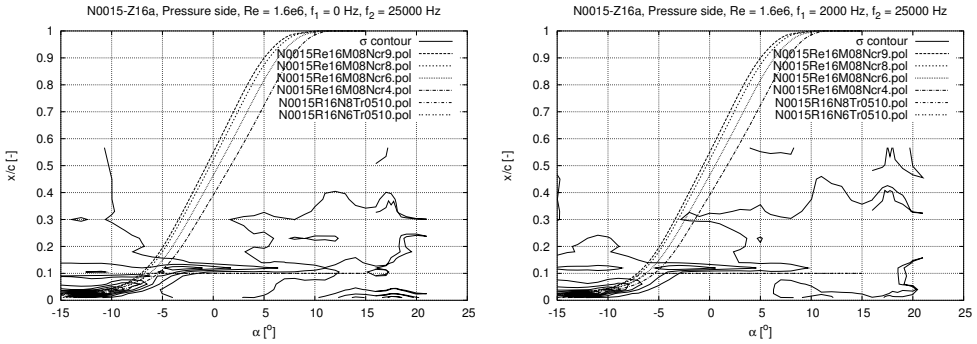

Figure 261: Contours of σ and XFoil data

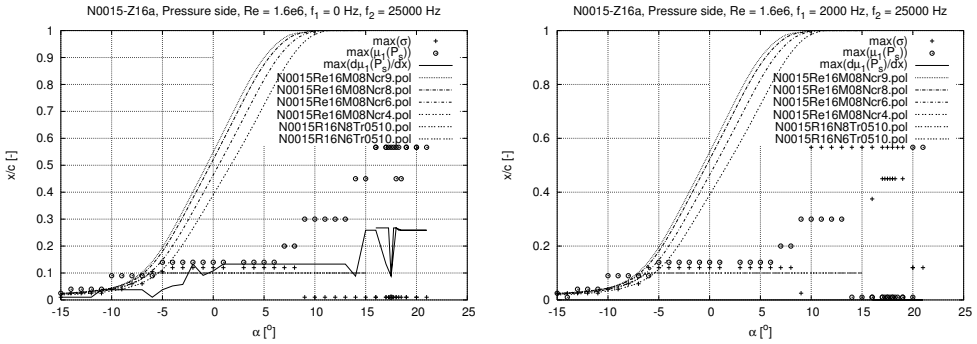

Figure 262: Transition detection

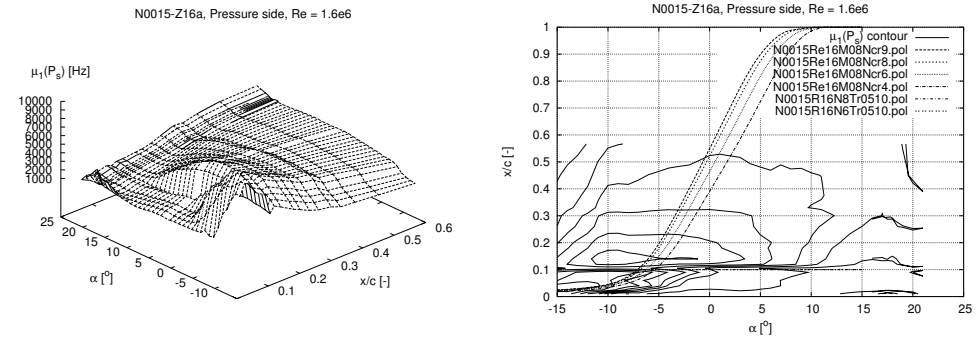

Figure 263: Fourier transform mean, $\mu_1(P_s)$

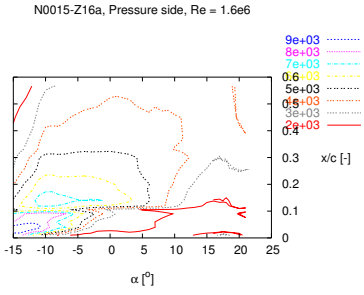

Figure 264: Contours of $\mu_1(P_s)$

```
N0015-Z16a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
16.00	0.2674	9485.4	3776.1
17.00	0.2674	8512.1	3730.4
17.25	0.2674	8526.7	3679.4
17.50	0.0883	9018.3	3660.6
17.75	0.2674	8732.3	3702.4
18.00	0.2674	9508.3	3739.0
18.25	0.2590	10518.7	3827.0
19.00	0.2590	11549.2	4022.6
20.00	0.2590	12523.7	4184.2
21.00	0.2590	14655.2	4402.7
20.00	0.2590	12300.6	4217.5
19.00	0.2590	11107.5	3900.6
18.50	0.2590	10740.6	3844.8
18.00	0.2674	8598.9	3645.0
17.50	0.0883	9387.9	3679.6
17.00	0.1331	8029.2	3590.0
16.00	0.2590	8611.0	3605.3
15.00	0.2590	10063.5	3624.1
14.00	0.0883	11480.4	3720.6
13.00	0.1331	14325.1	3855.0
12.00	0.1331	20726.2	4049.1
11.00	0.1331	27153.0	4229.8
10.00	0.1331	31395.1	4334.3
9.00	0.1331	36999.8	4422.5
8.00	0.1331	42500.3	4484.5
7.00	0.1331	47567.9	4786.6
6.00	0.1331	52082.1	5050.0
5.00	0.1331	55947.1	5491.0
4.00	0.1331	58045.7	5794.9
3.00	0.1331	60230.8	6156.8
1.00	0.1331	67382.4	6631.0
0.00	0.1079	62687.3	6856.6
-1.00	0.0911	59742.5	6992.4
-2.00	0.1331	54153.3	7046.4
-3.00	0.0576	49421.6	7045.0
-4.00	0.0520	56730.9	7003.4
-5.00	0.0380	65733.7	7030.7
-6.00	0.0100	76697.8	7277.3
-7.00	0.0380	73768.1	8034.6
-8.00	0.0380	90212.0	8425.0
-9.00	0.0380	97160.6	8676.4
-10.00	0.0380	84988.0	8817.2
-11.00	0.0380	61254.4	9173.0
-12.00	0.0100	52797.2	9843.0
-13.00	0.0100	34223.4	9909.9
-14.00	0.0100	11678.5	9653.2
-15.00	0.0100	6605.3	9544.6

5.16 Z3a ZZ90 x/c=5% suc. x/c=10% press. 200x200

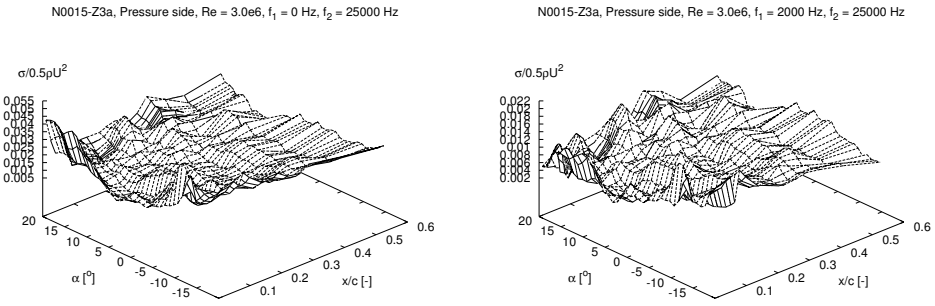

Figure 265: Pressure standard deviations, σ

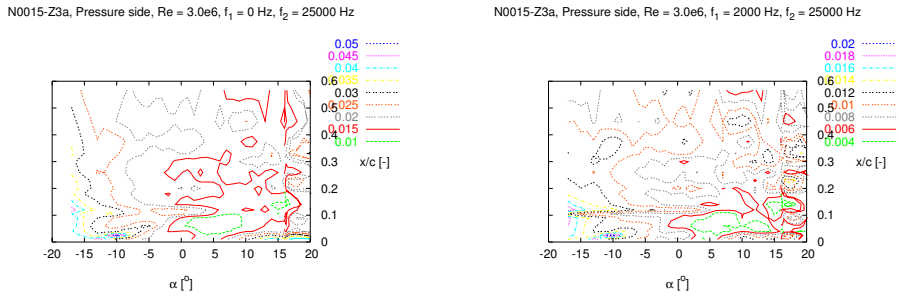

Figure 266: Contours of σ

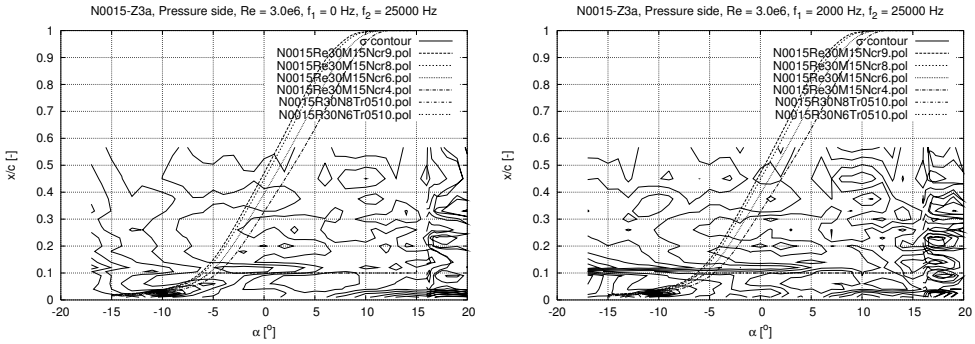

Figure 267: Contours of σ and XFoil data

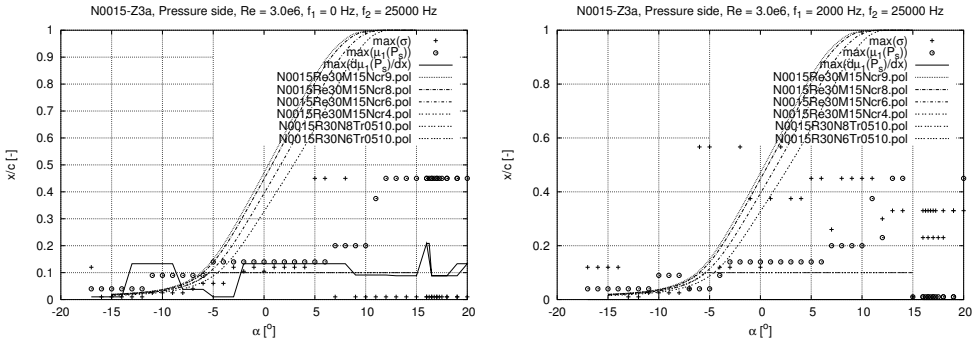

Figure 268: Transition detection

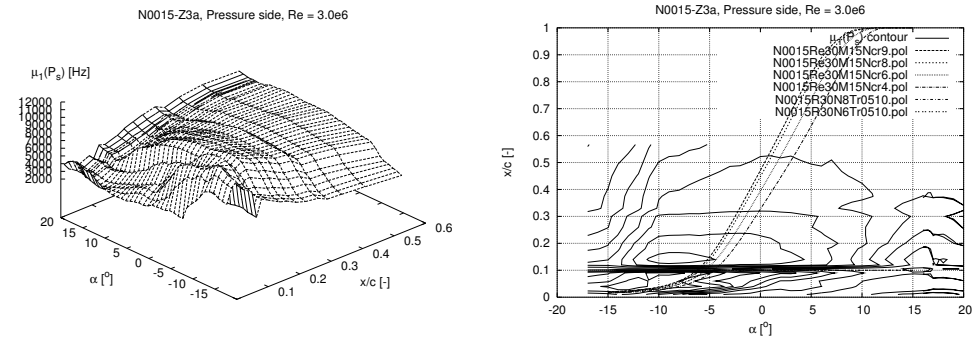

Figure 269: Fourier transform mean, $\mu_1(P_s)$

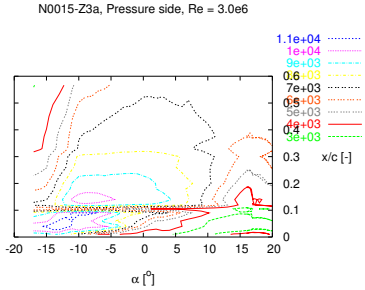

Figure 270: Contours of $\mu_1(P_s)$

```
N0015-Z3a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.2086     16740.3    6359.6
 16.25  0.2086     16939.8    6438.6
 16.50  0.0883     17758.2    6452.0
 16.75  0.0883     20065.0    6480.5
 17.00  0.0883     20229.9    6601.9
 17.25  0.0883     20331.6    6582.8
 18.00  0.0883     22333.9    6548.6
 19.00  0.1331     23083.8    6656.1
 20.00  0.1331     25260.7    6848.1
 19.00  0.0883     22321.9    6638.7
 18.00  0.0883     20636.5    6509.3
 17.50  0.0883     21382.4    6497.6
 17.00  0.0883     19667.2    6518.7
 16.50  0.0883     16133.3    6394.1
 16.00  0.2086     16847.9    6498.9
 15.00  0.0883     21725.7    6465.7
 14.00  0.0883     32854.5    6556.1
 13.00  0.0883     42469.8    6827.3
 12.00  0.0911     52255.8    6835.4
 11.00  0.0911     59165.1    7024.4
 10.00  0.0911     61423.8    7218.0
  9.00  0.0911     62707.2    7592.7
  8.00  0.1331     67447.9    7872.2
  7.00  0.1331     73938.0    8217.2
  6.00  0.1331     75542.4    8415.1
  5.00  0.1331     78958.1    8806.4
  4.00  0.1331     82047.0    9082.6
  3.00  0.1331     85452.0    9288.2
  2.00  0.1331     90280.7    9503.5
  1.00  0.1331     91111.9    9672.4
  0.00  0.1331     88107.3    9811.9
 -1.00  0.1331     86390.0    9912.4
 -2.00  0.1331     83671.1    9911.0
 -3.00  0.0100     78979.0    9939.8
 -4.00  0.0100     82306.6    9927.5
 -5.00  0.0100     81719.6   10082.2
 -6.00  0.0380     91532.8   10562.1
 -7.00  0.0380    100977.1   10907.3
 -8.00  0.0380     81448.0   11123.8
 -9.00  0.1331     79049.5   11226.7
-10.00  0.1331     79236.1   11143.8
-11.00  0.1331     74225.8   11098.6
-12.00  0.1331     59874.0   11495.6
-13.00  0.1331     45068.2   11848.5
-14.00  0.0100     32291.9   11628.5
-15.00  0.0100     29295.9   11109.0
-16.00  0.0100     29367.2   10958.9
-17.00  0.0100     27993.2   10788.6
```

5.17 Z6a ZZ90 x/c=5% suc. x/c=10% press. 200x200

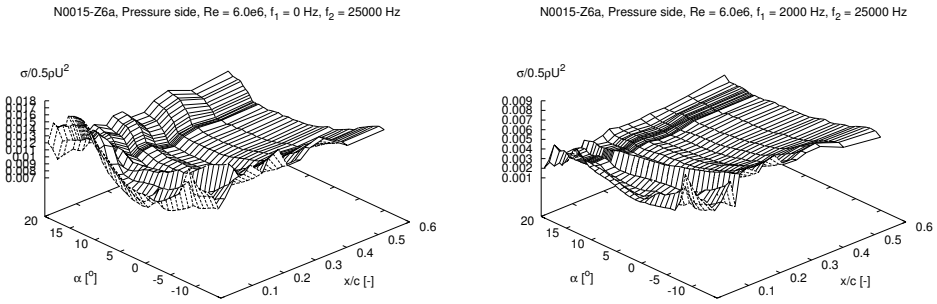

Figure 271: Pressure standard deviations, σ

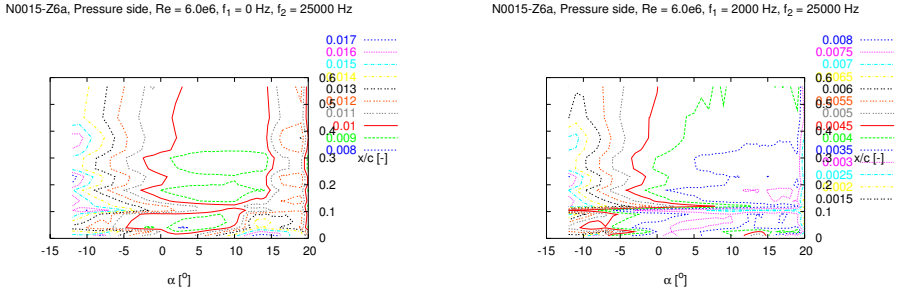

Figure 272: Contours of σ

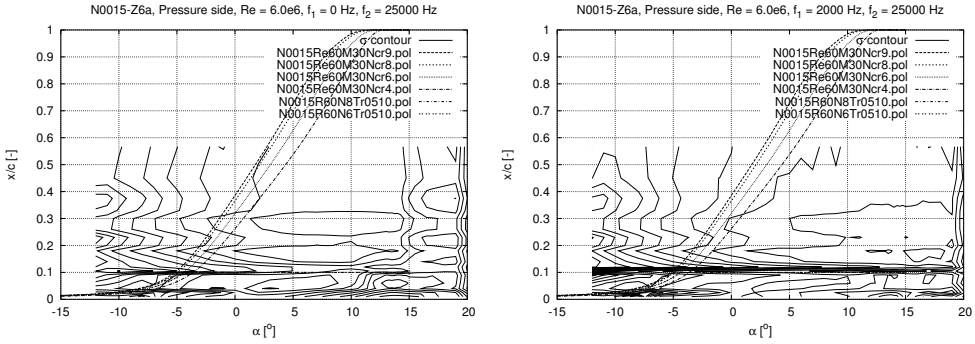

Figure 273: Contours of σ and XFoil data

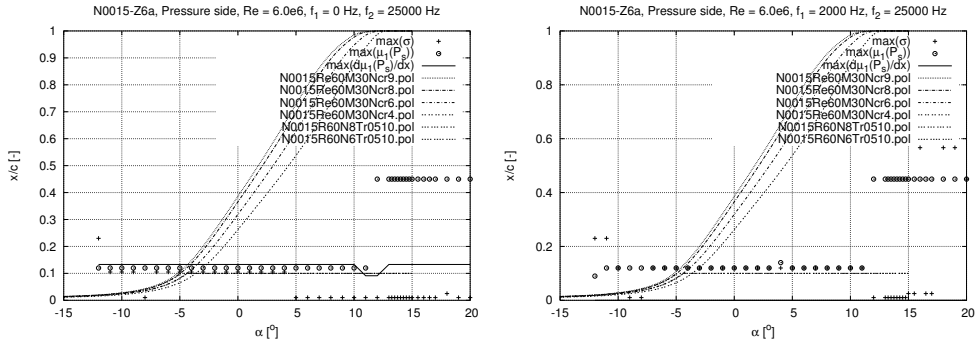

Figure 274: Transition detection

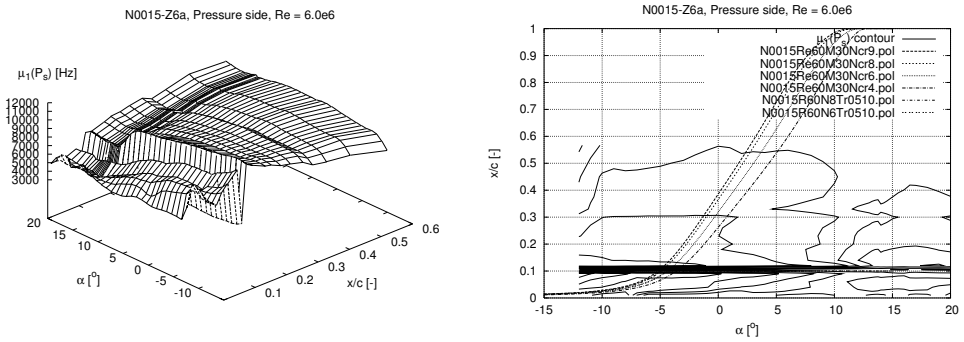

Figure 275: Fourier transform mean, $\mu_1(P_s)$

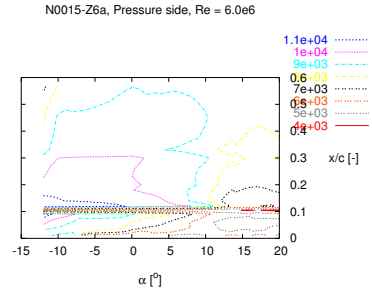

Figure 276: Contours of $\mu_1(P_s)$

```
N0015-Z6a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.1331     99229.6   11739.9
-11.00  0.1331    104640.0   11924.7
-10.00  0.1331    106650.3   11952.6
 -9.00  0.1331    105260.1   11856.1
 -8.00  0.1331    105286.6   11693.9
 -7.00  0.1331    105132.7   11544.6
 -6.00  0.1331    106086.6   11456.1
 -5.00  0.1331    104267.1   11321.4
 -4.00  0.1331    104063.2   11257.6
 -3.00  0.1331    101925.5   11178.6
 -2.00  0.1331    101469.1   11103.4
 -1.00  0.1331    100086.3   10993.9
  0.00  0.1331    100752.0   10904.9
  1.00  0.1331     98717.9   10737.2
  2.00  0.1331     96602.5   10612.1
  3.00  0.1331     95041.8   10491.9
  4.00  0.1331     91635.8   10344.8
  5.00  0.1331     88714.5   10214.1
  6.00  0.1331     85733.5   10136.4
```

7.00	0.1331	82920.4	10082.3
8.00	0.1331	79069.1	9999.9
9.00	0.1331	75518.3	9885.2
10.00	0.1331	72145.6	9645.0
11.00	0.0911	64582.7	9063.1
12.00	0.0911	54045.5	8674.9
13.00	0.1331	46447.8	8572.9
13.25	0.1331	45125.3	8531.3
13.50	0.1331	44549.8	8502.3
13.75	0.1331	43646.8	8465.6
14.00	0.1331	45811.2	8660.5
14.25	0.1331	45272.8	8624.9
14.50	0.1331	46117.6	8542.1
14.75	0.1331	46554.7	8495.0
15.00	0.1331	46874.6	8408.5
15.50	0.1331	46969.6	8356.7
16.00	0.1331	46135.3	8312.5
16.50	0.1331	44078.1	8207.7
17.00	0.1331	43339.8	8249.6
18.00	0.1331	47040.8	8293.1
19.00	0.1331	51433.1	8402.3
20.00	0.1331	52713.3	8678.6

5.18 T16a Trip wire. Bump tape 2% 200x200

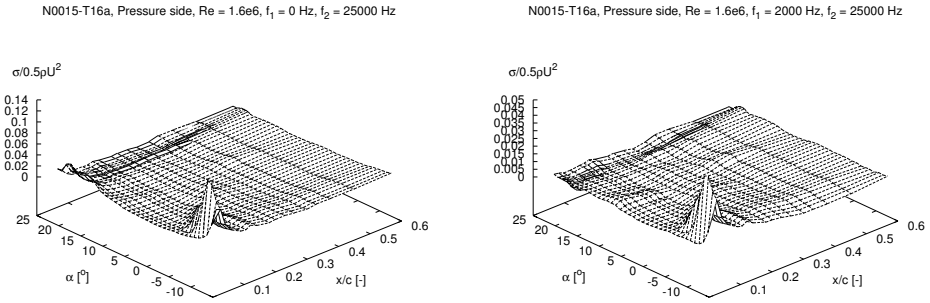

Figure 277: Pressure standard deviations, σ

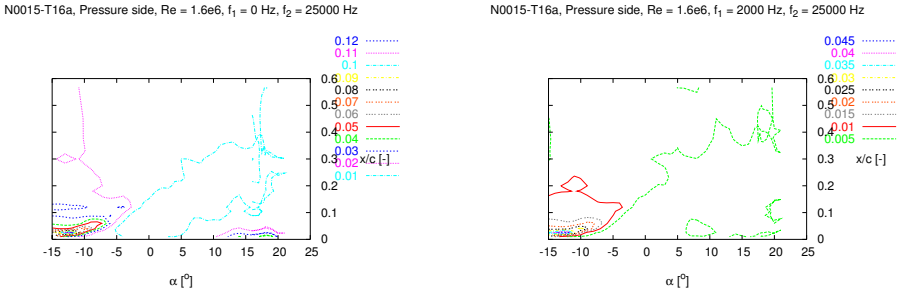

Figure 278: Contours of σ

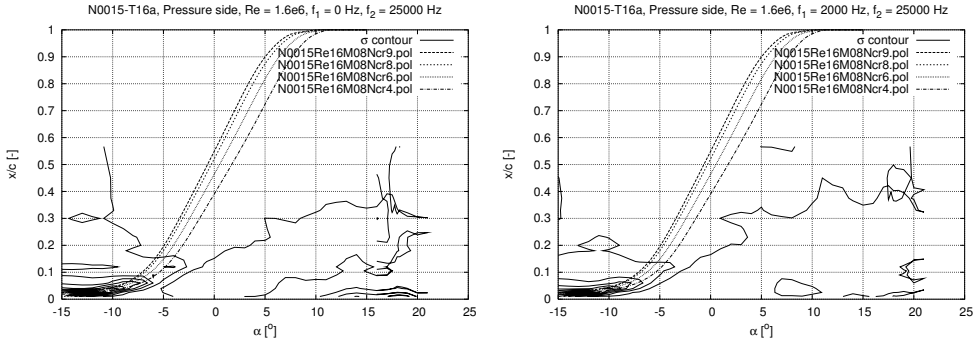

Figure 279: Contours of σ and XFoil data

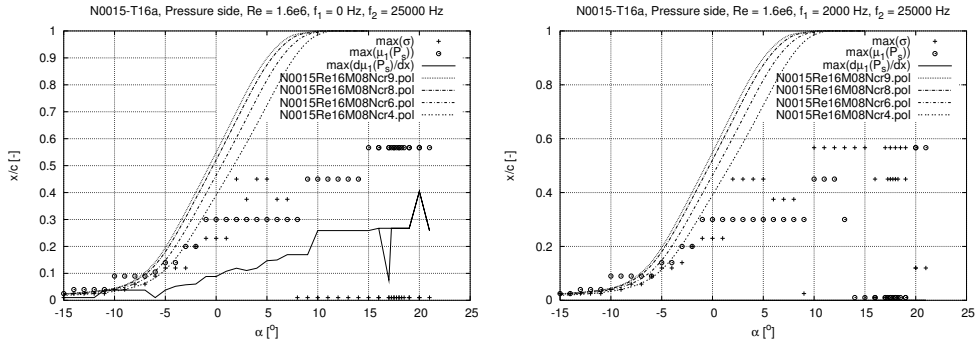

Figure 280: Transition detection

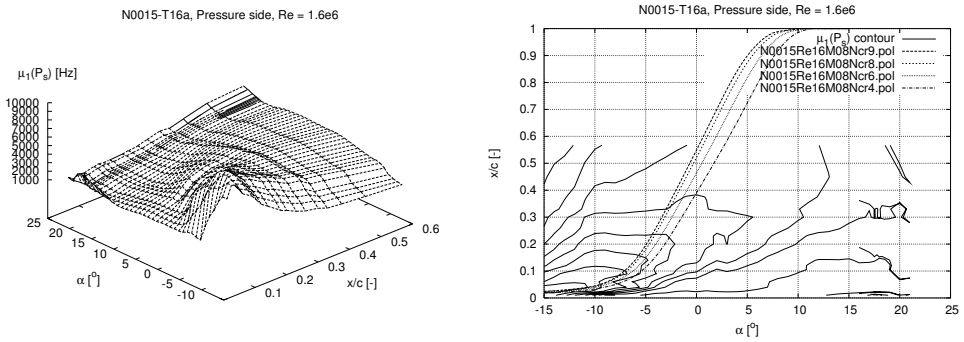

Figure 281: Fourier transform mean, $\mu_1(P_s)$

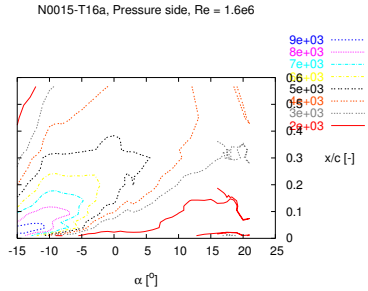

Figure 282: Contours of $\mu_1(P_s)$

```
N0015-T16a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.2674      8236.7    3545.2
 17.00  0.0743      8194.8    3659.8
 17.25  0.2674      9211.6    3780.5
 17.50  0.2674      9121.3    3811.5
 17.75  0.2674      9564.1    3897.7
 18.00  0.2674      9350.5    3894.9
 18.25  0.2674      9367.9    3938.4
 19.00  0.2674      9123.1    4088.6
 20.00  0.4044      9414.2    4348.7
 21.00  0.2590      9697.5    4512.7
 20.00  0.4044      8469.6    4330.7
 19.00  0.2674      9415.2    3981.0
 18.50  0.2674      9808.7    3828.5
 18.00  0.2674      9125.3    3729.8
 17.50  0.2674      8797.0    3673.3
 17.00  0.2674      8346.3    3675.3
 16.00  0.2674      8971.3    3680.7
 15.00  0.2590     10665.4    3677.0
 14.00  0.2590     11447.8    3794.5
```

13.00	0.2590	12220.4	4016.4
12.00	0.2590	12865.3	4188.3
11.00	0.2590	13411.0	4325.6
10.00	0.2590	13906.7	4378.2
9.00	0.1694	15547.2	4441.8
8.00	0.1694	18784.9	4565.8
7.00	0.1694	19719.9	4717.3
6.00	0.1499	21427.8	4937.0
5.00	0.1471	21445.6	5076.5
4.00	0.1191	24653.3	5204.7
3.00	0.1107	29456.9	5401.8
2.00	0.1191	26736.5	5390.6
1.00	0.1079	30221.5	5547.2
0.00	0.0883	39859.3	5698.2
-1.00	0.0883	40808.9	5721.5
-2.00	0.0604	45002.4	5949.3
-3.00	0.0576	51427.2	6332.3
-4.00	0.0520	59444.9	6642.3
-5.00	0.0380	66676.9	7101.9
-6.00	0.0100	73713.0	7437.6
-7.00	0.0380	78541.2	8131.3
-8.00	0.0380	91228.3	8532.2
-9.00	0.0380	101538.8	8814.4
-10.00	0.0380	82653.7	8915.2
-11.00	0.0380	64248.8	9245.6
-12.00	0.0100	53078.1	9864.1
-13.00	0.0100	34788.2	9881.1
-14.00	0.0100	12839.8	9629.3
-15.00	0.0100	8077.0	9494.1

5.19 T3a Trip wire. Bump tape 2% 200x200

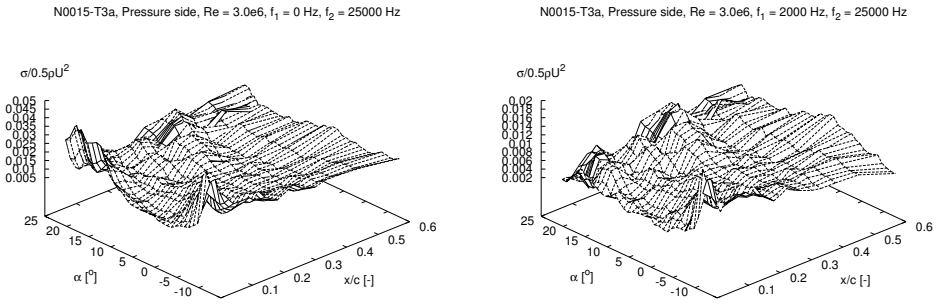

Figure 283: Pressure standard deviations, σ

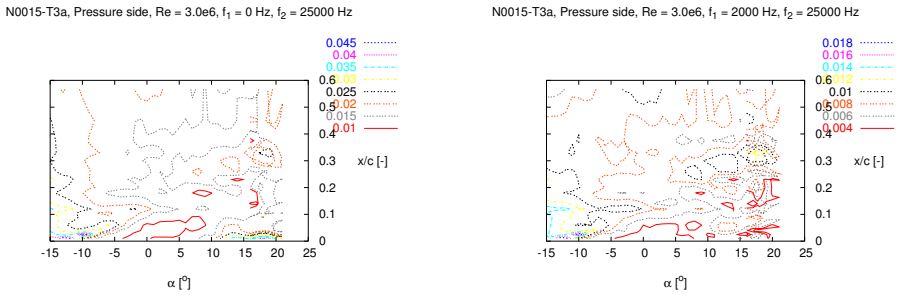

Figure 284: Contours of σ

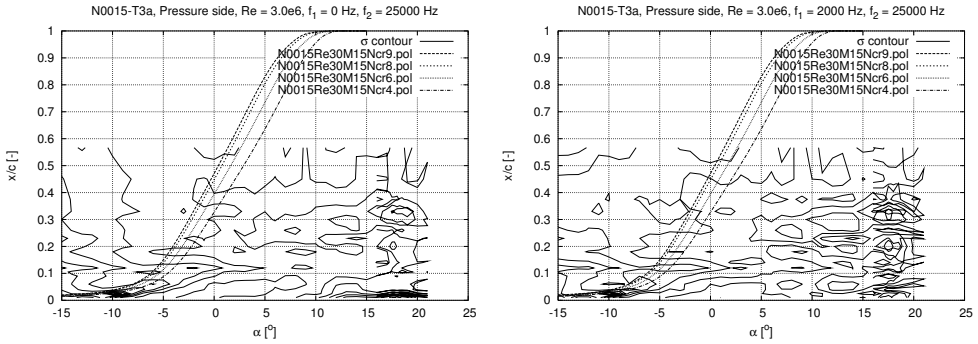

Figure 285: Contours of σ and XFoil data

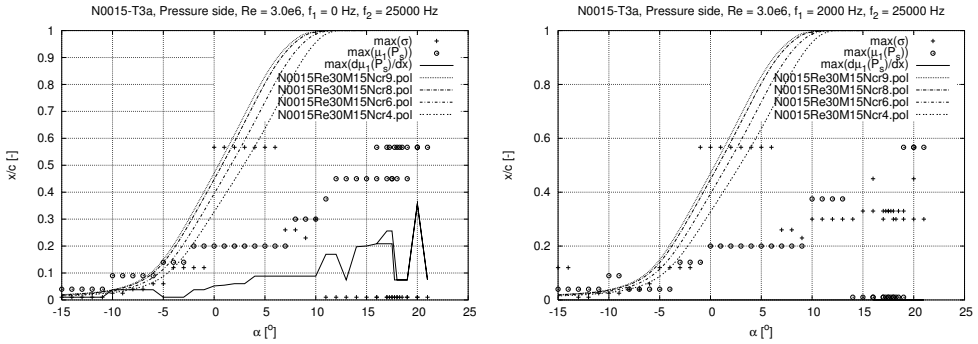

Figure 286: Transition detection

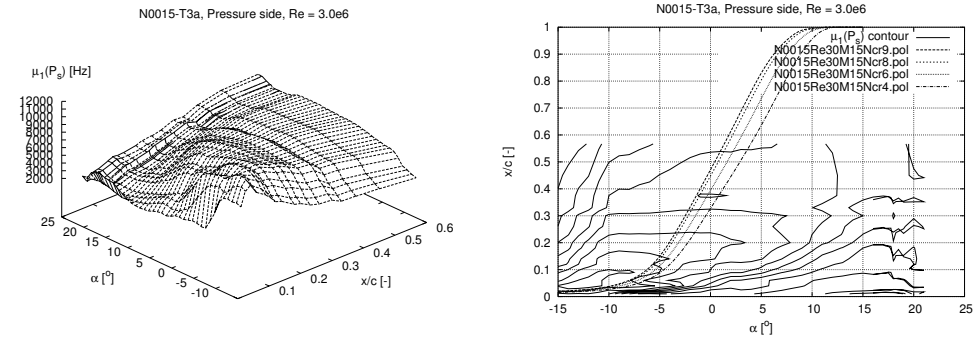

Figure 287: Fourier transform mean, $\mu_1(P_s)$

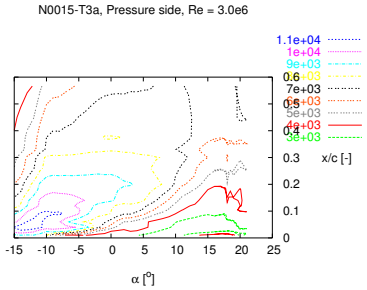

Figure 288: Contours of $\mu_1(P_s)$

```
N0015-T3a
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
16.00	0.2086	16934.3	6465.4
17.00	0.2086	16336.5	6395.0
17.25	0.2086	15778.9	6381.5
17.50	0.2086	15474.9	6357.1
17.75	0.0743	15185.4	6424.1
18.00	0.0743	19617.4	6664.5
18.25	0.0743	17733.5	6687.1
19.00	0.0743	17388.2	6912.7
20.00	0.3569	18157.7	7267.4
21.00	0.0743	16636.4	7250.3
20.00	0.3569	17708.1	7206.2
19.00	0.0743	17908.9	6858.9
18.50	0.0743	16768.7	6641.3
18.00	0.0743	17764.9	6754.8
17.50	0.2562	16209.8	6457.7
17.00	0.2562	16600.1	6411.6
16.00	0.2086	17804.9	6520.0
15.00	0.2002	18587.3	6612.2
14.00	0.1974	20676.6	6656.2
13.00	0.0743	22574.5	6841.5
12.00	0.1694	23295.9	7156.5
11.00	0.1694	25117.5	7383.6
10.00	0.0883	28410.0	7568.8
9.00	0.0883	32974.3	7777.4
8.00	0.0883	38501.7	7948.5
7.00	0.0883	42991.1	8257.8
6.00	0.0883	47802.3	8585.1
5.00	0.0883	49347.3	8715.4
4.00	0.0883	49823.7	8884.3
3.00	0.0604	48365.7	9069.3
2.00	0.0604	51751.8	9125.7
1.00	0.0548	56801.4	9280.0
0.00	0.0520	62164.4	9487.1
-1.00	0.0380	63383.7	9534.0
-2.00	0.0380	68626.6	9537.4
-3.00	0.0100	78348.6	9773.3
-4.00	0.0100	85342.5	9989.1
-5.00	0.0100	83093.9	10118.2
-6.00	0.0380	92708.3	10539.4
-7.00	0.0380	100524.9	10853.8
-8.00	0.0380	91601.1	11123.6
-9.00	0.0380	71201.0	11066.2
-10.00	0.0380	47100.0	11189.5
-11.00	0.0100	47847.3	11212.1
-12.00	0.0100	42871.7	11609.2
-13.00	0.0100	39541.7	11687.2
-14.00	0.0100	30510.2	11490.8
-15.00	0.0100	27218.6	11082.9

5.20 T6a Trip wire. Bump tape 2% 200x200

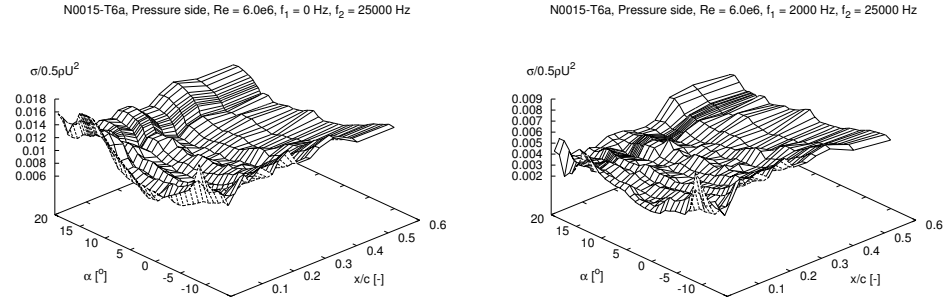

Figure 289: Pressure standard deviations, σ

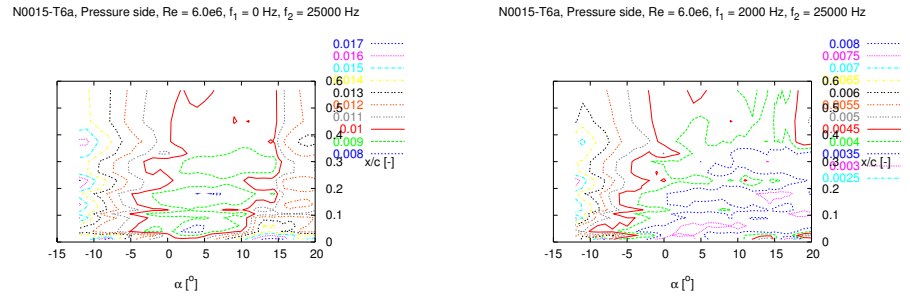

Figure 290: Contours of σ

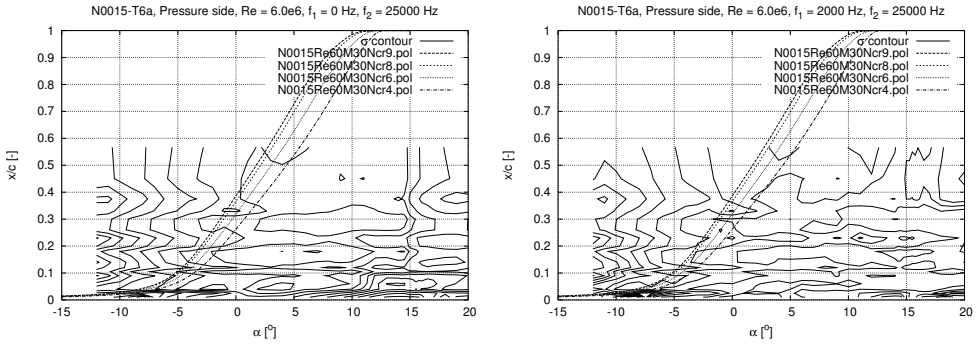

Figure 291: Contours of σ and XFoil data

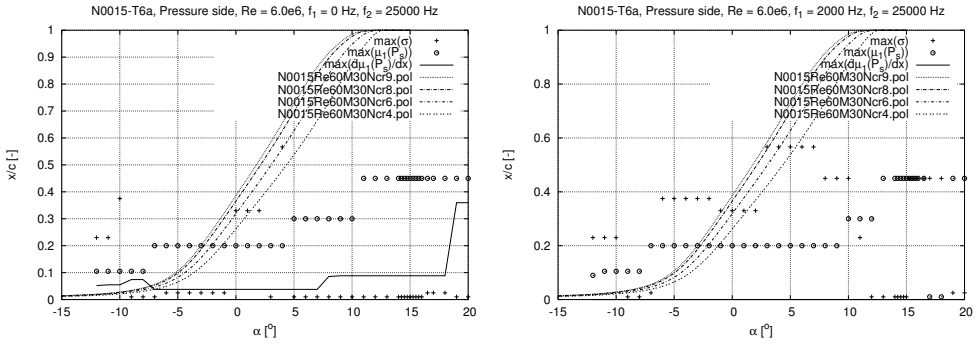

Figure 292: Transition detection

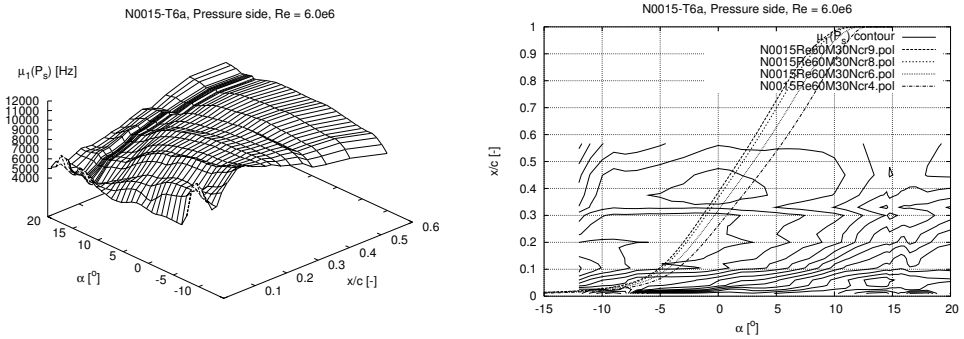

Figure 293: Fourier transform mean, $\mu_1(P_s)$

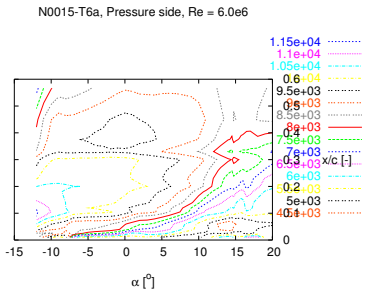

Figure 294: Contours of $\mu_1(P_s)$

N0015-T6a
alpha [degrees] angle of attack
xtr* [-] transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx* [Hz/-] d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1) [Hz] max mu1 of all chordwise positions

alpha	xtr*	d(mu1)/dx*	max(mu1)
-12.00	0.0520	48495.2	11561.5
-11.00	0.0548	39338.5	11236.6
-10.00	0.0548	33968.2	10977.0
-9.00	0.0743	29182.6	10808.0
-8.00	0.0743	28040.4	10621.7
-7.00	0.0380	42218.3	10507.7
-6.00	0.0380	61521.1	10499.9
-5.00	0.0380	60234.9	10444.5
-4.00	0.0380	60374.5	10416.1
-3.00	0.0380	59640.5	10406.1
-2.00	0.0380	59866.6	10368.8
-1.00	0.0380	59456.3	10314.7
0.00	0.0380	55183.3	10272.2
1.00	0.0380	47592.5	10146.2
2.00	0.0380	41814.8	10073.7
3.00	0.0380	40794.0	9997.8
4.00	0.0380	41306.0	9858.2
5.00	0.0380	41853.4	9765.6
6.00	0.0380	39781.1	9630.3
7.00	0.0380	35178.7	9566.7
8.00	0.0855	32046.9	9412.5
9.00	0.0883	29516.1	9298.4
10.00	0.0883	27555.8	9178.9
11.00	0.0883	25636.7	8986.2
12.00	0.0883	29678.1	8816.6
13.00	0.0883	32928.8	8581.8
14.00	0.0883	32508.0	8388.0
14.25	0.0883	31961.6	8365.3
14.50	0.0883	31343.5	8318.8
14.75	0.0883	26924.8	8537.8
15.00	0.0883	24289.7	8502.6
15.25	0.0883	22040.8	8477.9
15.50	0.0883	20204.2	8467.2
15.75	0.0883	20385.8	8393.3
16.00	0.0883	21176.1	8372.1
16.50	0.0883	26833.1	8305.8
17.00	0.0883	25578.5	8309.0
18.00	0.0883	15938.3	8537.7
19.00	0.3597	13980.5	8565.8
20.00	0.3597	15264.0	8591.9

5.21 C16b Clean 100x100

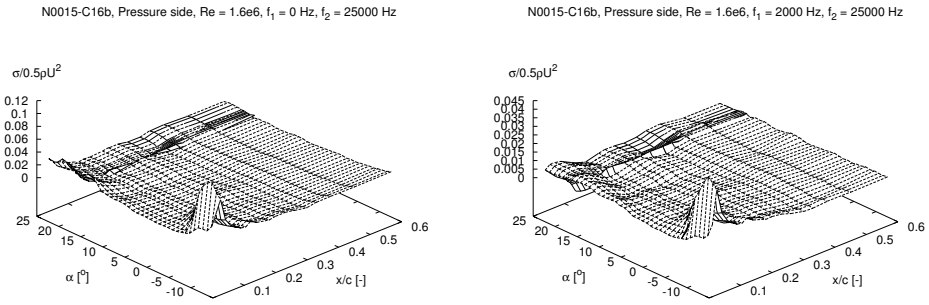

Figure 295: Pressure standard deviations, σ

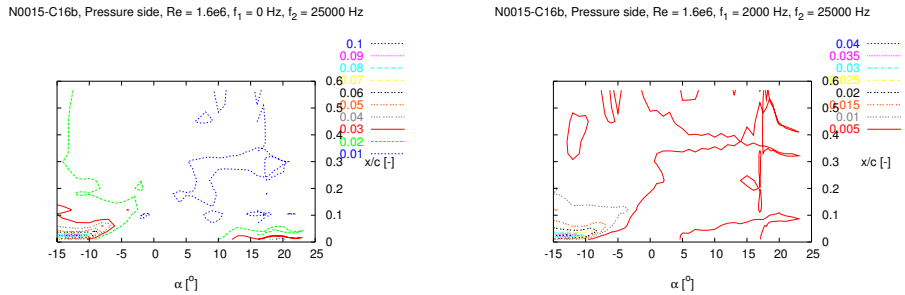

Figure 296: Contours of σ

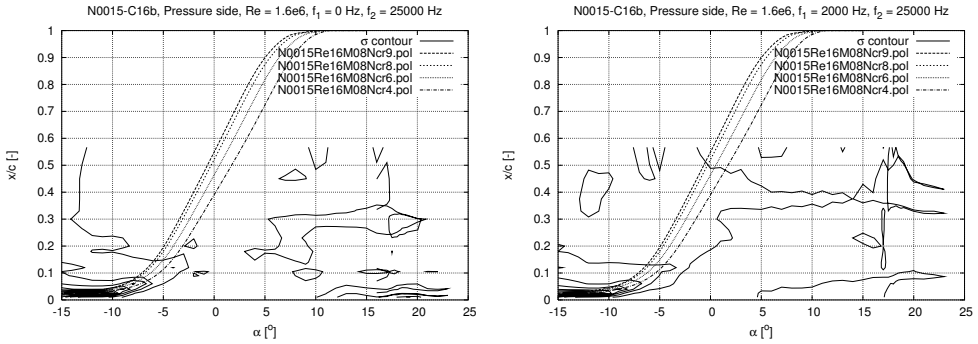

Figure 297: Contours of σ and XFoil data

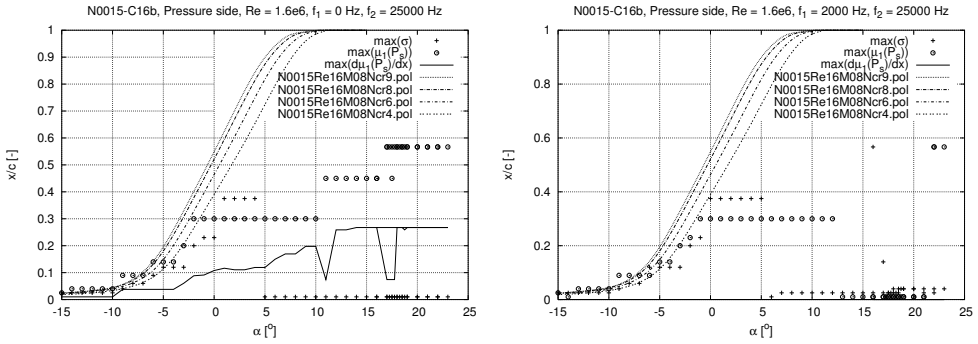

Figure 298: Transition detection

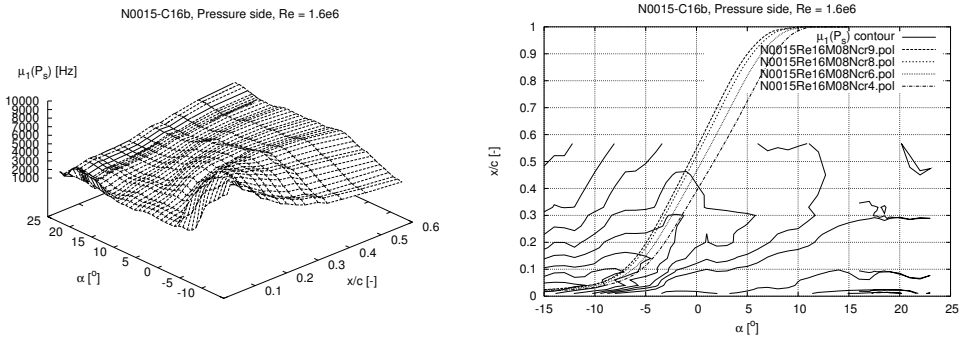

Figure 299: Fourier transform mean, $\mu_1(P_s)$

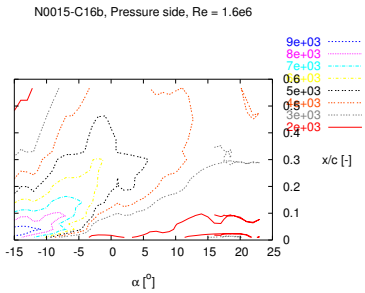

Figure 300: Contours of $\mu_1(P_s)$

```
N0015-C16b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.2674      7858.3    3364.9
 17.00  0.0743      8659.5    3594.6
 17.25  0.0743      8743.1    3609.4
 17.50  0.0743      8286.6    3544.6
 17.75  0.0743      8244.3    3591.0
 18.00  0.2674      8761.9    3653.4
 18.25  0.2674      8681.7    3660.5
 18.50  0.2674      8693.6    3723.7
 18.75  0.2590      8860.7    3739.0
 19.00  0.2674      9312.0    3802.1
 20.00  0.2674      9585.1    3989.5
 21.00  0.2674     10255.5    4054.9
 22.00  0.2674      9501.7    4199.2
 23.00  0.2674      9696.3    4254.3
 22.00  0.2674      9777.3    4249.2
 21.00  0.2674     10310.1    4157.1
 20.00  0.2674      9697.2    3969.2
 19.00  0.2674      9962.3    3839.1
 18.50  0.2674     10172.7    3777.9
 18.00  0.2674      8911.6    3682.8
 17.50  0.2674      8550.6    3628.0
 17.00  0.2674      8859.1    3604.2
 16.00  0.2674      9330.7    3630.0
 15.00  0.2674     10401.2    3618.5
 14.00  0.2674     10726.6    3708.9
 13.00  0.2590     11147.1    3936.9
 12.00  0.2590     11553.6    4150.6
 11.00  0.0743     11338.4    4273.6
 10.00  0.1974     13654.4    4493.5
  9.00  0.1974     13581.9    4497.2
  8.00  0.1694     16197.0    4564.9
  7.00  0.1694     19595.1    4700.8
  6.00  0.1499     19838.9    4969.6
  5.00  0.1191     21344.1    5113.6
  4.00  0.1191     23565.0    5190.7
  3.00  0.1107     26317.3    5311.9
  2.00  0.1107     28500.3    5391.5
  1.00  0.1163     24902.2    5424.1
  0.00  0.1079     30149.6    5738.8
 -1.00  0.0911     34053.0    5971.5
 -2.00  0.0883     38637.9    6088.2
 -3.00  0.0604     49773.4    6545.6
 -4.00  0.0380     53874.9    6896.8
 -5.00  0.0380     60868.6    7106.5
 -6.00  0.0380     67615.1    7298.9
 -7.00  0.0380     73976.0    7942.3
 -8.00  0.0380     74956.5    8310.4
 -9.00  0.0380     63438.9    8311.9
-10.00  0.0100     41860.0    8748.0
-11.00  0.0100     37163.7    9041.2
-12.00  0.0100     31828.0    9278.4
-13.00  0.0100     28345.3    9674.8
-14.00  0.0100     15131.1    9753.2
-15.00  0.0100      5866.0    9776.0
```

5.22 C3b Clean 100x100

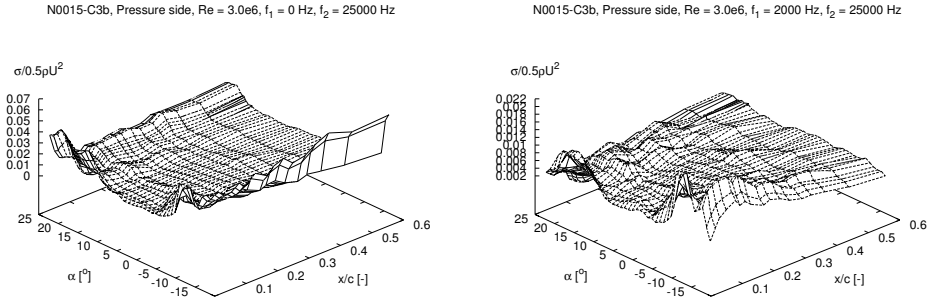

Figure 301: Pressure standard deviations, σ

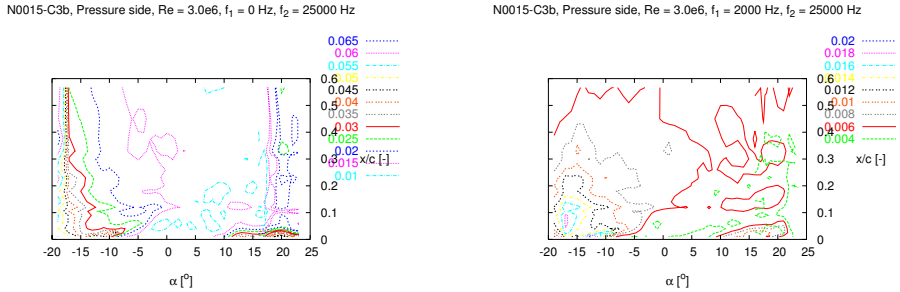

Figure 302: Contours of σ

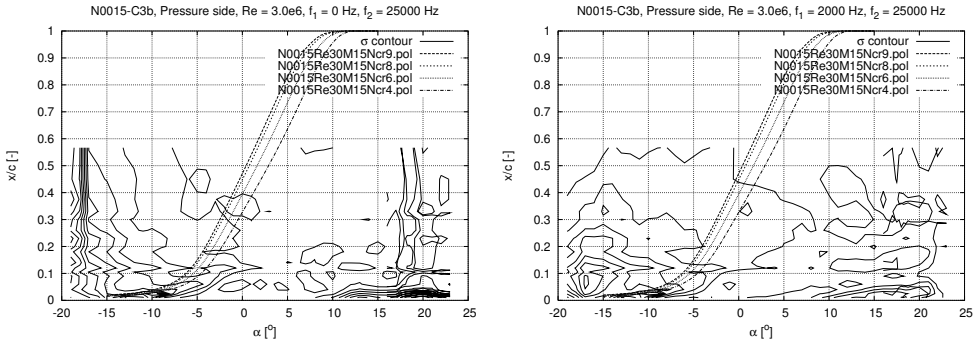

Figure 303: Contours of σ and XFoil data

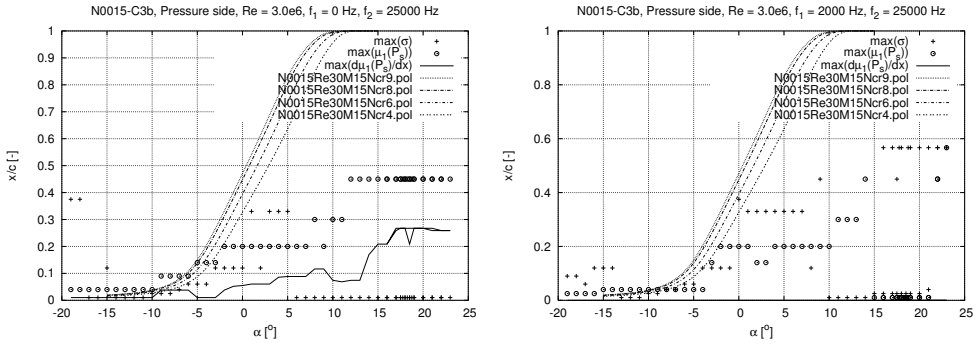

Figure 304: Transition detection

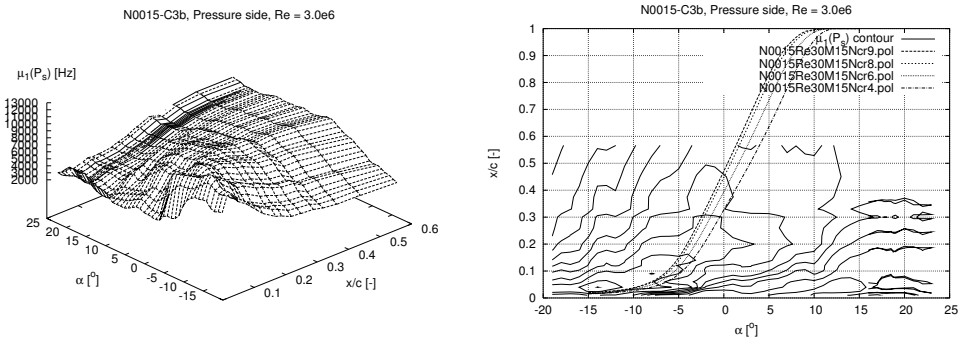

Figure 305: Fourier transform mean, $\mu_1(P_s)$

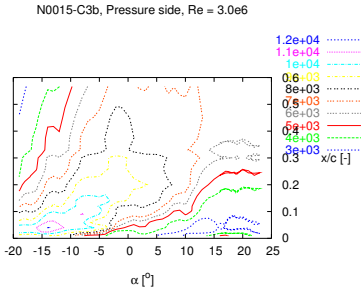

Figure 306: Contours of $\mu_1(P_s)$

```
N0015-C3b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 16.00  0.2086     17678.7    6425.0
 17.00  0.2590     19227.1    6432.9
 17.50  0.2674     17472.3    6405.9
 17.75  0.2674     17857.4    6512.3
 18.00  0.2674     17915.2    6535.2
 18.25  0.2674     17634.3    6518.0
 18.50  0.2674     17863.1    6523.7
 18.75  0.2674     17619.1    6602.4
 19.00  0.2674     18196.6    6623.8
 20.00  0.2674     18703.7    6513.7
 21.00  0.2590     20327.7    6822.7
 22.00  0.2590     19950.5    6838.7
 23.00  0.2590     20856.0    6937.5
 22.00  0.2590     19704.3    6901.3
 21.00  0.2674     17857.1    6728.0
 20.00  0.2674     16633.0    6518.1
 19.00  0.2674     15659.1    6577.1
 18.50  0.2086     15407.3    6543.9
 18.00  0.2674     15717.7    6506.6
```

17.50	0.2674	16691.8	6481.1
17.00	0.2674	18247.2	6454.2
16.00	0.2086	17313.8	6495.1
15.00	0.2086	17867.9	6573.5
14.00	0.1694	19433.7	6798.8
13.00	0.0743	21938.6	6996.3
12.00	0.0743	28711.0	7222.9
11.00	0.0687	36277.5	7504.9
10.00	0.0743	38095.6	7735.0
9.00	0.1163	35084.4	7792.3
8.00	0.1163	36226.5	7941.6
7.00	0.0883	40293.7	8120.9
6.00	0.0883	45767.7	8359.4
5.00	0.0883	49730.3	8710.6
4.00	0.0855	48520.4	8930.8
3.00	0.0604	48832.5	9036.4
2.00	0.0604	52357.2	9132.3
1.00	0.0604	54333.6	9243.4
0.00	0.0548	61322.0	9488.9
-1.00	0.0520	66362.4	9650.8
-2.00	0.0380	70717.3	9840.7
-3.00	0.0100	94618.3	9957.5
-4.00	0.0100	88424.9	10265.5
-5.00	0.0100	76979.9	10225.0
-6.00	0.0380	82105.4	10493.2
-7.00	0.0380	89533.9	10853.9
-8.00	0.0380	87865.9	11044.3
-9.00	0.0380	61589.8	10789.3
-10.00	0.0100	44189.3	10708.8
-11.00	0.0100	37475.4	10852.1
-12.00	0.0100	38324.6	11418.7
-13.00	0.0100	40508.5	11830.5
-14.00	0.0100	35935.9	12018.0
-15.00	0.0100	29502.9	11672.8
-16.00	0.0100	26423.4	11009.6
-17.00	0.0100	24198.0	10664.7
-18.00	0.0100	22894.2	10741.2
-19.00	0.0100	17995.6	10680.6

5.23 C6b Clean 100x100

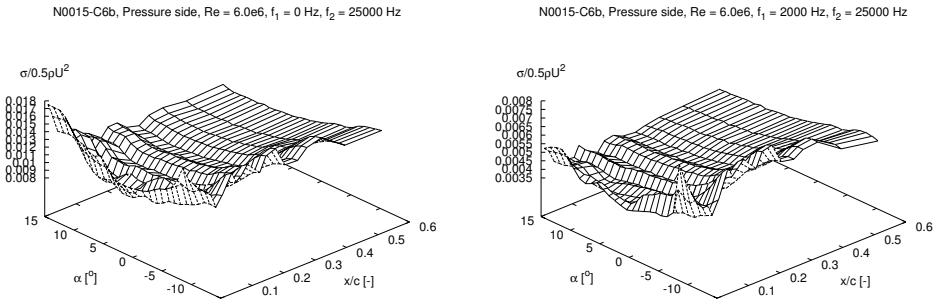

Figure 307: Pressure standard deviations, σ

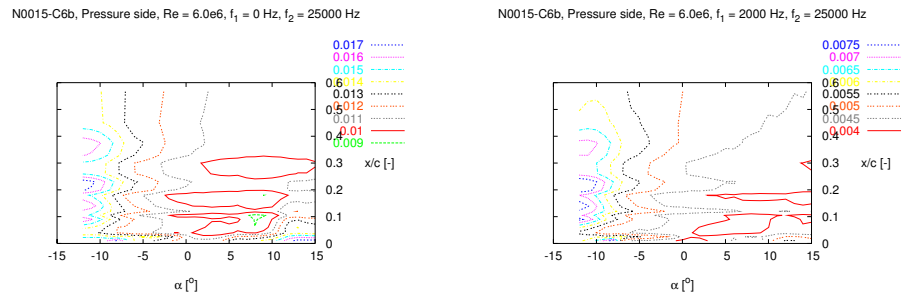

Figure 308: Contours of σ

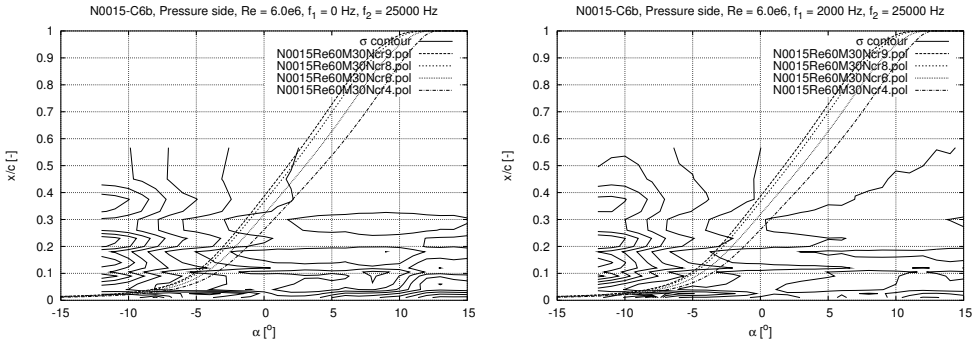

Figure 309: Contours of σ and XFoil data

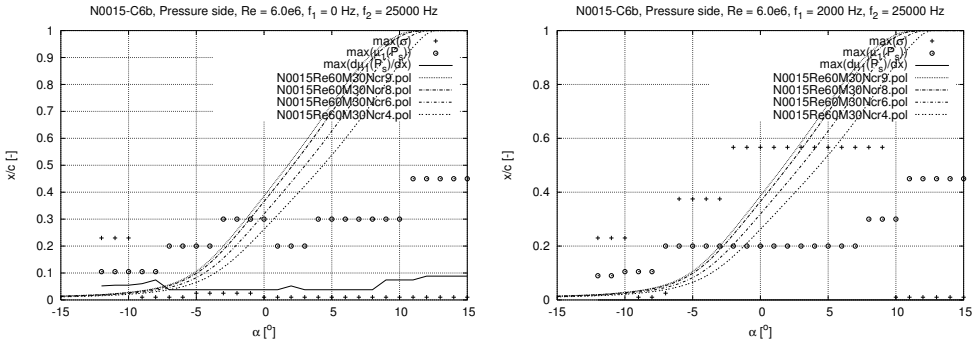

Figure 310: Transition detection

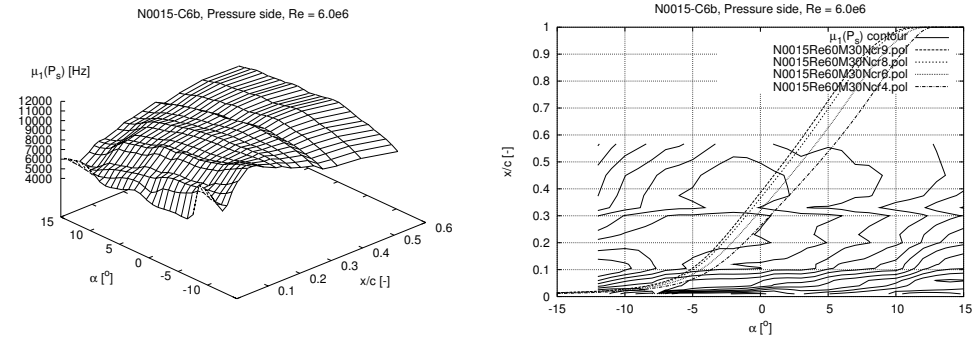

Figure 311: Fourier transform mean, $\mu_1(P_s)$

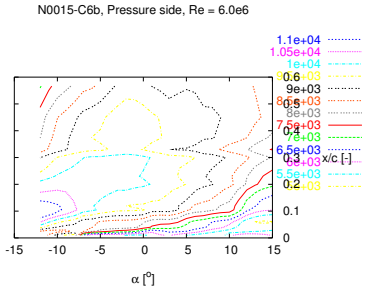

Figure 312: Contours of $\mu_1(P_s)$

```
N0015-C6b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.0520     47860.2   11492.1
-11.00  0.0548     44988.3   11314.3
-10.00  0.0548     38931.6   11114.0
 -9.00  0.0604     33666.3   10875.8
 -8.00  0.0743     28892.8   10603.8
 -7.00  0.0380     45147.3   10379.0
 -6.00  0.0380     57198.7   10381.4
 -5.00  0.0380     53748.2   10263.6
 -4.00  0.0380     51001.0   10234.0
 -3.00  0.0380     51239.2   10189.0
 -2.00  0.0380     52667.0   10260.6
 -1.00  0.0380     53362.5   10207.3
  0.00  0.0380     50282.1   10099.6
  1.00  0.0380     41069.3    9972.2
  2.00  0.0520     35125.3    9894.4
  3.00  0.0380     33201.8    9746.2
  4.00  0.0380     34234.6    9659.7
  5.00  0.0380     31781.9    9611.0
  6.00  0.0380     30439.5    9503.4
  7.00  0.0380     31142.4    9310.2
  8.00  0.0380     29319.8    9236.2
  9.00  0.0743     29456.8    9081.9
 10.00  0.0743     31897.3    8922.9
 11.00  0.0743     28894.3    8866.4
 12.00  0.0883     27292.8    8793.2
 13.00  0.0883     25919.5    8608.4
 14.00  0.0883     23901.5    8442.3
 15.00  0.0883     21620.5    8301.2
```

5.24 Z16b ZZ90 x/c=5% suc. x/c=10% press. 100x100

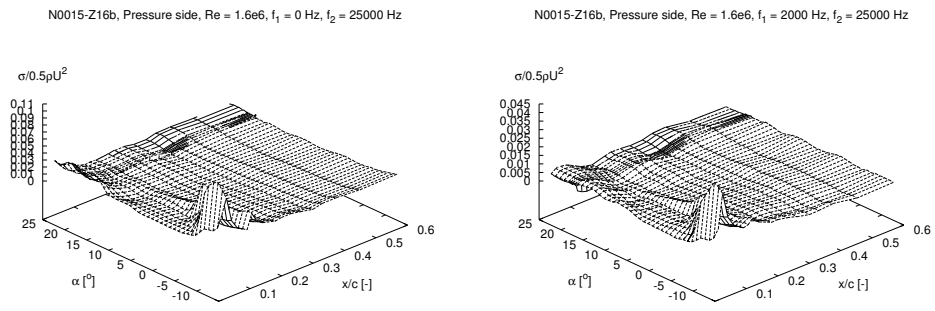

Figure 313: Pressure standard deviations, σ

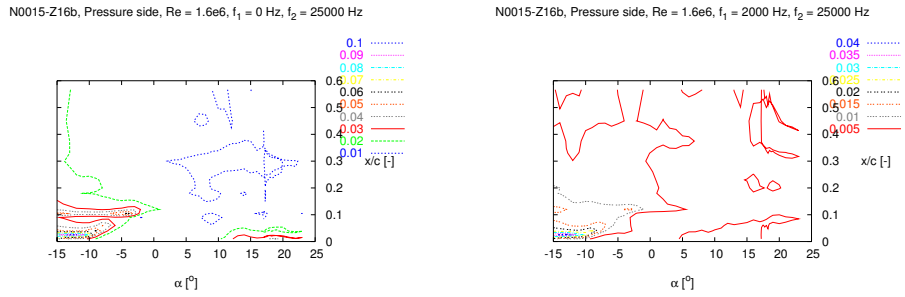

Figure 314: Contours of σ

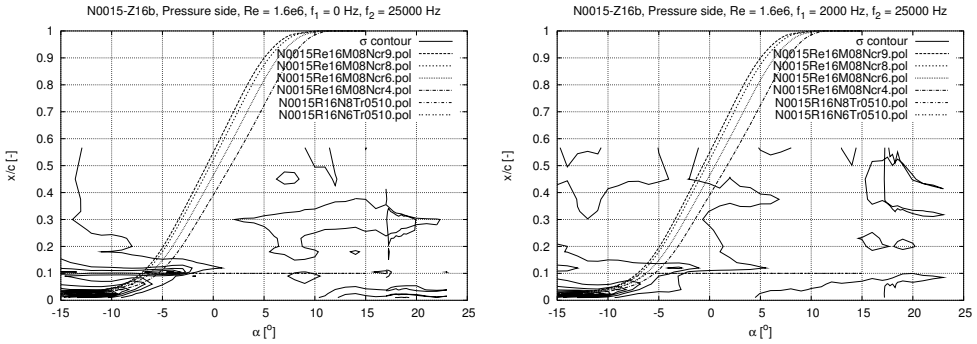

Figure 315: Contours of σ and XFoil data

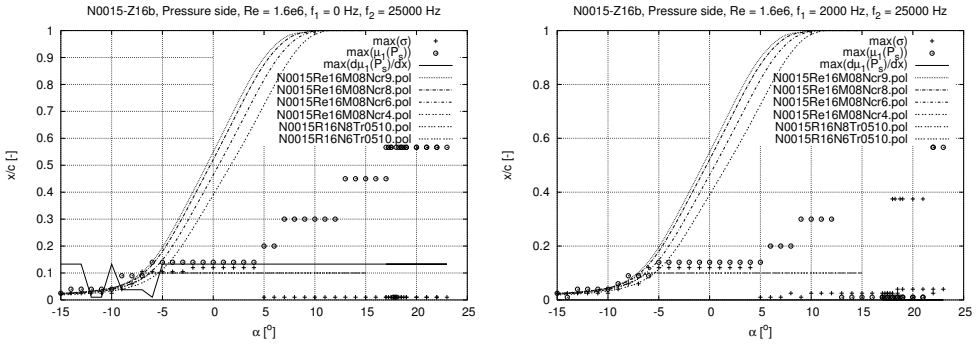

Figure 316: Transition detection

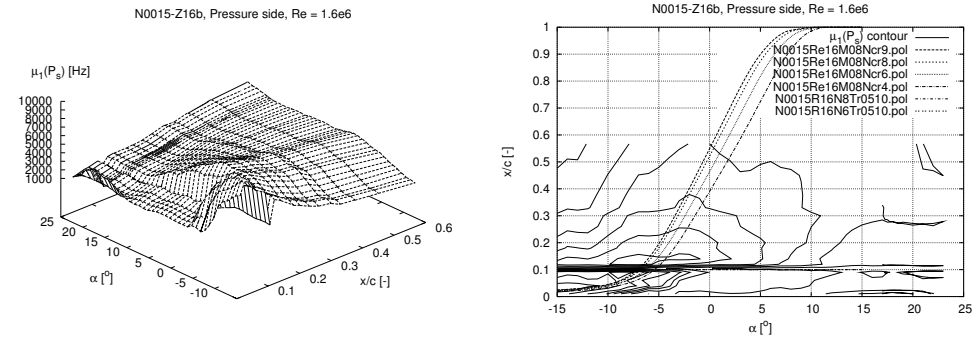

Figure 317: Fourier transform mean, $\mu_1(P_s)$

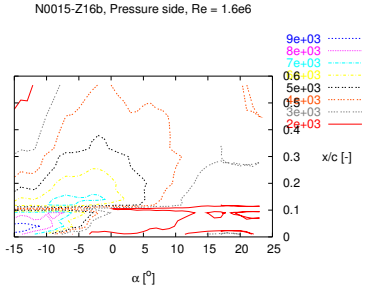

Figure 318: Contours of $\mu_1(P_s)$

```
N0015-Z16b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
17.00	0.1331	13056.1	3402.8
17.25	0.1331	14459.9	3517.7
17.50	0.1331	14455.5	3556.7
17.75	0.1331	14259.9	3615.0
18.00	0.1331	14418.6	3657.3
18.25	0.1331	14477.7	3627.7
18.50	0.1331	14495.3	3669.0
18.75	0.1331	14272.2	3689.0
19.00	0.1331	14038.6	3735.4
20.00	0.1331	14112.6	3903.3
21.00	0.1331	14087.9	3994.2
22.00	0.1331	14000.8	4137.1
23.00	0.1331	13962.9	4346.5
22.00	0.1331	13777.9	4145.8
21.00	0.1331	13634.5	4107.5
20.00	0.1331	13526.6	3942.4
19.00	0.1331	13544.0	3800.8
18.50	0.1331	13470.7	3710.9
18.00	0.1331	13863.1	3649.4
17.50	0.1331	14141.9	3603.3
17.00	0.1331	14146.2	3547.2
16.00	0.1331	14613.3	3548.7
15.00	0.1331	14727.2	3545.6
14.00	0.1331	15020.0	3617.0
13.00	0.1331	17438.1	3726.0
12.00	0.1331	20478.4	3910.5
11.00	0.1331	25119.0	3987.9
10.00	0.1331	33435.8	4138.3
9.00	0.1331	37825.9	4380.6
8.00	0.1331	40719.1	4494.3
7.00	0.1331	45175.4	4558.5
6.00	0.1331	49254.7	4857.2
5.00	0.1331	55948.7	5127.9
4.00	0.1331	63004.0	5427.2
3.00	0.1331	64350.2	5790.5
2.00	0.1331	66867.1	6028.5
1.00	0.1331	71649.4	6249.2
0.00	0.1331	73469.3	6679.5
-1.00	0.1331	74953.0	7015.2
-2.00	0.1331	75377.6	7212.7
-3.00	0.1331	72821.6	7205.1
-4.00	0.1331	65408.5	7089.3
-5.00	0.1331	60244.5	7102.3
-6.00	0.0100	75249.5	7195.6
-7.00	0.0380	73037.9	7809.1
-8.00	0.0380	68927.6	8224.1
-9.00	0.0380	63310.8	8189.8
-10.00	0.1331	41478.0	8703.5
-11.00	0.0100	35076.0	9017.3
-12.00	0.0100	30620.4	9226.6
-13.00	0.1331	31228.5	9560.3
-14.00	0.1331	32107.5	9692.0
-15.00	0.1331	27215.1	9756.0

5.25 Z3b ZZ90 x/c=5% suc. x/c=10% press. 100x100

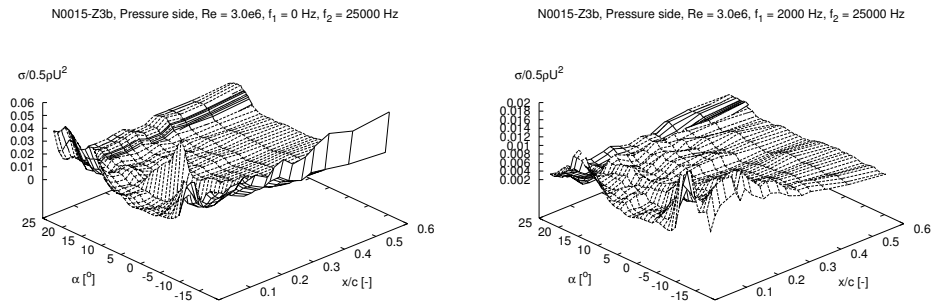

Figure 319: Pressure standard deviations, σ

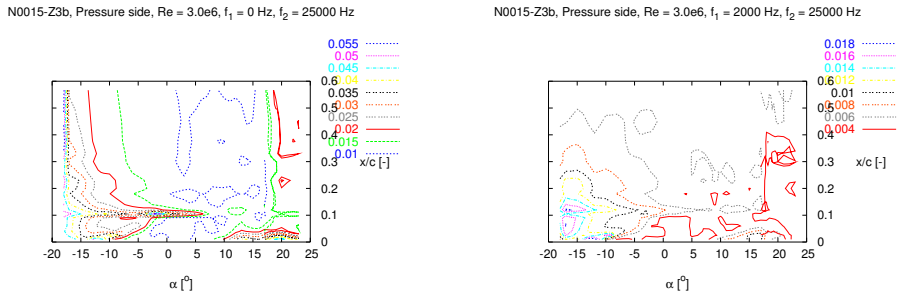

Figure 320: Contours of σ

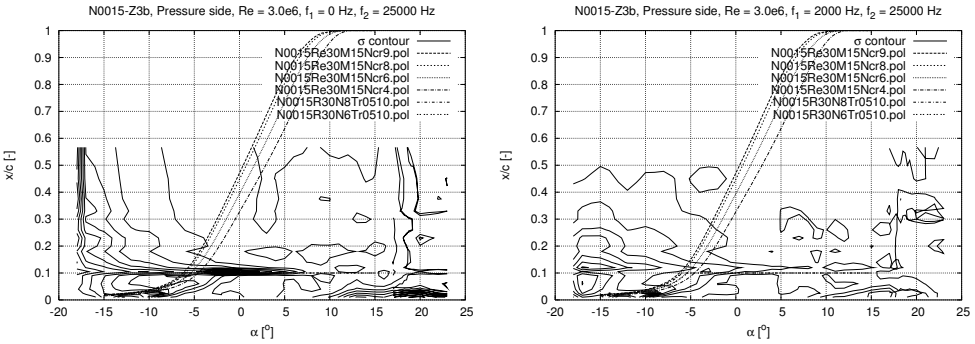

Figure 321: Contours of σ and XFoil data

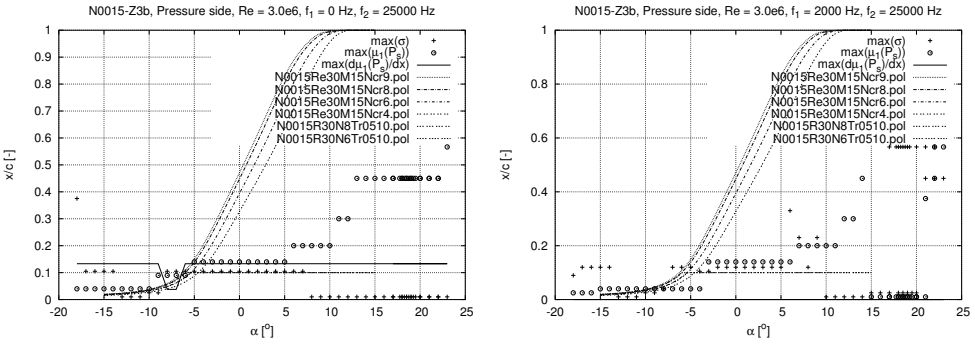

Figure 322: Transition detection

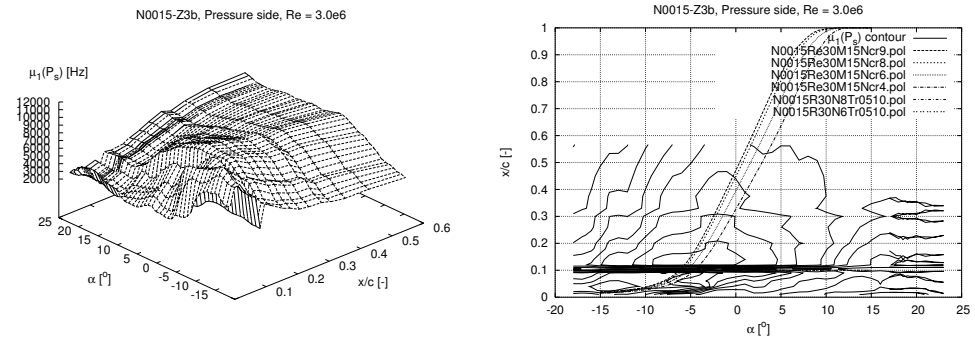

Figure 323: Fourier transform mean, $\mu_1(P_s)$

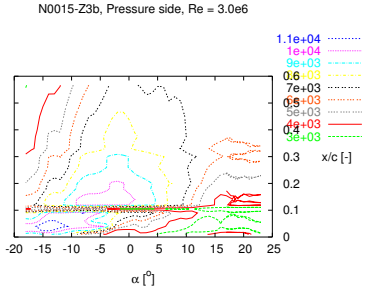

Figure 324: Contours of $\mu_1(P_s)$

```
N0015-Z3b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 17.00  0.1331     27431.8    6422.2
 17.75  0.1331     30454.9    6356.7
 18.00  0.1331     30678.0    6389.0
 18.25  0.1331     31385.2    6411.4
 18.50  0.1331     32941.7    6487.4
 18.75  0.1331     31673.8    6461.4
 19.00  0.1331     32391.2    6476.6
 19.25  0.1331     31452.1    6466.4
 20.00  0.1331     30621.6    6534.1
 21.00  0.1331     30705.9    6633.7
 22.00  0.1331     29648.5    6881.3
 23.00  0.1331     28989.1    6933.0
 22.00  0.1331     29651.5    6793.1
 21.00  0.1331     30746.8    6802.9
 20.00  0.1331     29619.6    6518.6
 19.50  0.1331     30130.7    6558.8
 19.00  0.1331     31115.0    6547.3
 18.50  0.1331     30030.0    6520.8
 18.00  0.1331     31328.4    6527.6
 17.00  0.1331     27131.2    6431.1
 16.00  0.1331     25120.5    6449.2
 15.00  0.1331     28664.5    6605.0
 14.00  0.1331     34473.3    6778.3
 13.00  0.1331     41823.5    6855.9
 12.00  0.1331     47923.3    6974.1
 11.00  0.1331     54282.4    7096.3
 10.00  0.1331     68399.6    7411.4
  9.00  0.1331     77961.1    7748.3
  8.00  0.1331     80510.2    7953.0
  7.00  0.1331     82423.8    8033.7
  6.00  0.1331     88476.6    8394.0
  5.00  0.1331     95177.1    8819.9
  4.00  0.1331    103426.3    9285.9
  3.00  0.1331    107932.2    9564.7
  2.00  0.1331    110963.4    9779.7
  1.00  0.1331    116247.1   10005.2
  0.00  0.1331    119469.5   10271.9
 -1.00  0.1331    122671.5   10484.3
 -2.00  0.1331    123577.3   10645.4
 -3.00  0.1331    114677.5   10578.3
 -4.00  0.1331    100805.8   10453.4
 -5.00  0.1331     94063.0   10377.5
 -6.00  0.1331     90549.7   10437.0
 -7.00  0.0380     91033.7   10873.9
 -8.00  0.0380     88122.2   11049.8
 -9.00  0.1331     84916.6   10846.1
-10.00  0.1331     78592.5   10879.6
-11.00  0.1331     70465.0   11042.2
-12.00  0.1331     61789.9   11436.0
-13.00  0.1331     62970.4   11844.1
-14.00  0.1331     58819.3   11995.4
-15.00  0.1331     47307.9   11673.9
-16.00  0.1331     36790.6   11065.3
-17.00  0.1331     32084.8   10743.8
-18.00  0.1331     30502.2   10743.5
```

5.26 Z6b ZZ90 x/c=5% suc. x/c=10% press. 100x100

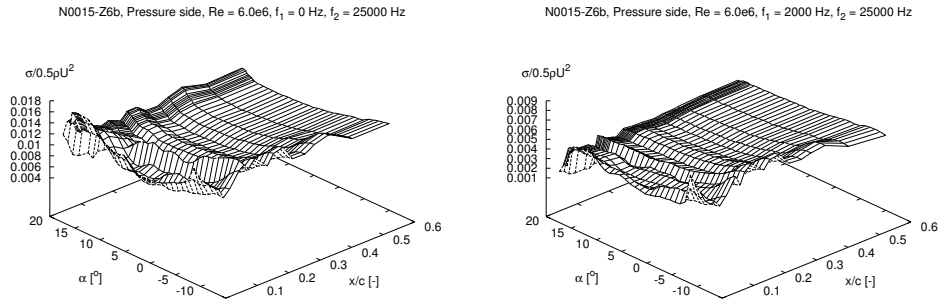

Figure 325: Pressure standard deviations, σ

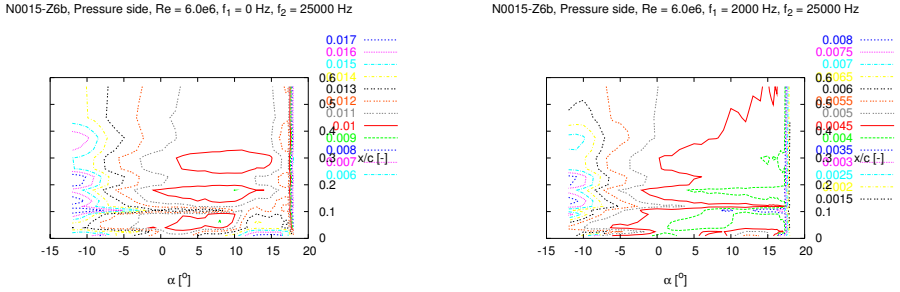

Figure 326: Contours of σ

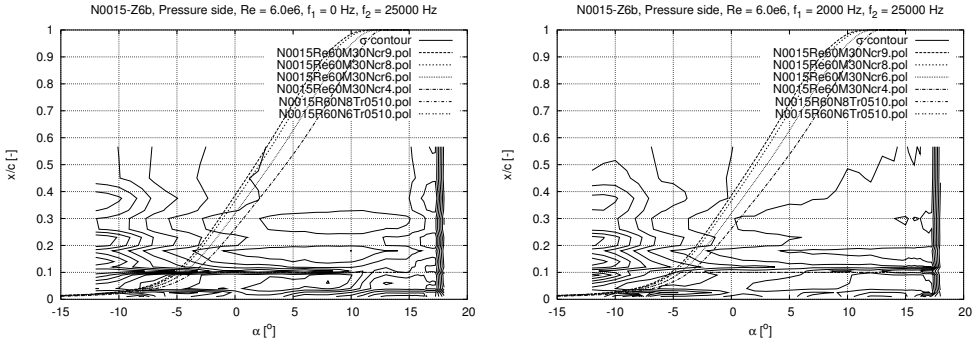

Figure 327: Contours of σ and XFoil data

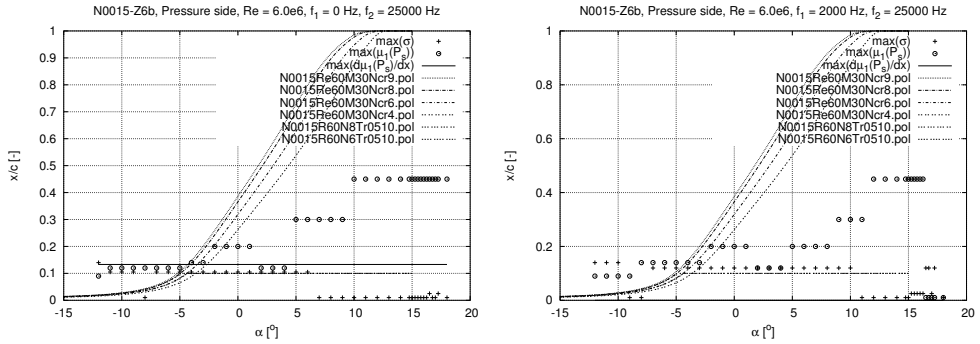

Figure 328: Transition detection

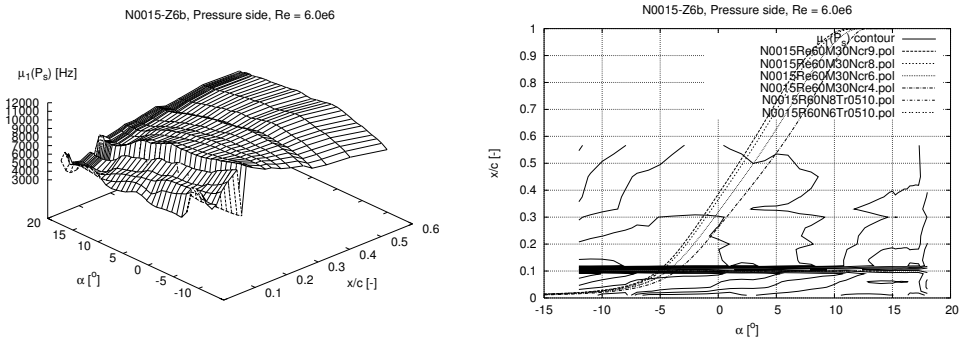

Figure 329: Fourier transform mean, $\mu_1(P_s)$

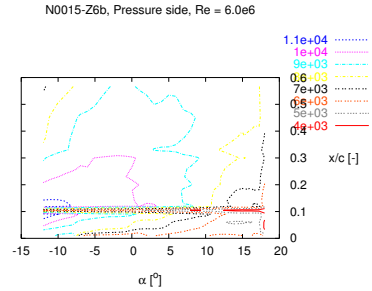

Figure 330: Contours of $\mu_1(P_s)$

```
N0015-Z6b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.1331     78062.8   11544.5
-11.00  0.1331     82804.9   11474.4
-10.00  0.1331     84460.3   11347.1
 -9.00  0.1331     84294.6   11161.0
 -8.00  0.1331     83361.5   10956.4
 -7.00  0.1331     82493.8   10784.5
 -6.00  0.1331     81529.4   10684.6
 -5.00  0.1331     82198.0   10467.7
 -4.00  0.1331     82172.9   10406.8
 -3.00  0.1331     79726.8   10247.6
 -2.00  0.1331     77766.6   10197.1
 -1.00  0.1331     76766.7   10162.2
  0.00  0.1331     78586.2   10090.8
  1.00  0.1331     81375.4    9995.2
  2.00  0.1331     83712.7   10070.3
  3.00  0.1331     83441.2   10075.6
  4.00  0.1331     81003.7    9856.8
  5.00  0.1331     80356.3    9560.2
  6.00  0.1331     80761.7    9485.9
```

7.00	0.1331	79580.5	9279.4
8.00	0.1331	81791.0	9165.6
9.00	0.1331	79235.7	9035.2
10.00	0.1331	70596.2	8830.8
11.00	0.1331	60021.5	8729.3
12.00	0.1331	57972.2	8646.8
13.00	0.1331	56343.8	8549.0
14.00	0.1331	54130.5	8386.9
14.75	0.1331	52880.7	8285.4
15.00	0.1331	52687.8	8264.7
15.25	0.1331	53844.7	8360.9
15.50	0.1331	53560.3	8344.5
15.75	0.1331	53121.3	8323.1
16.00	0.1331	52706.7	8279.5
16.25	0.1331	52900.6	8284.3
16.50	0.1331	56188.3	8202.5
16.75	0.1331	56028.2	8200.8
17.00	0.1331	55873.1	8182.0
17.25	0.1331	55737.4	8197.3
18.00	0.1331	41449.4	7288.9

5.27 T16b Trip wire. Bump tape 2% 100x100

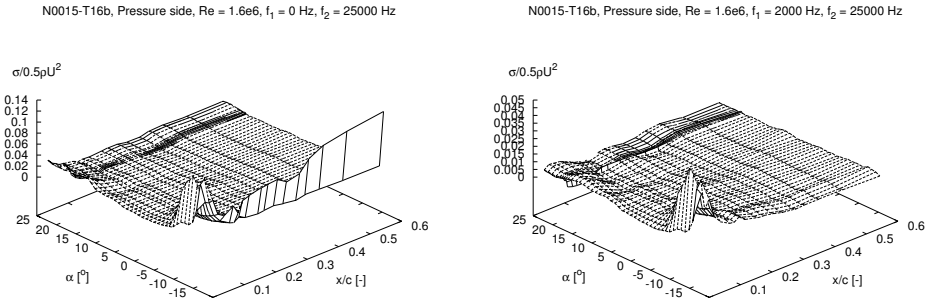

Figure 331: Pressure standard deviations, σ

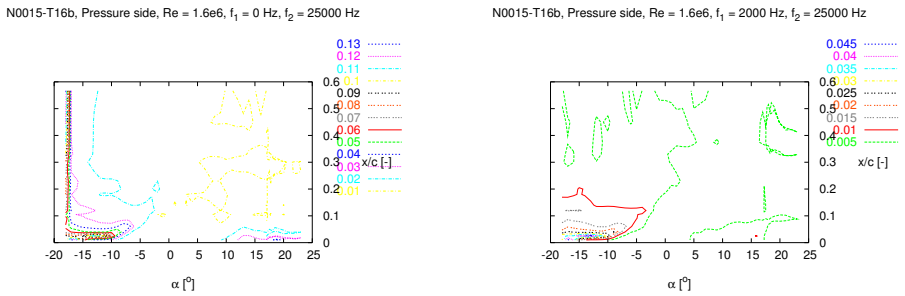

Figure 332: Contours of σ

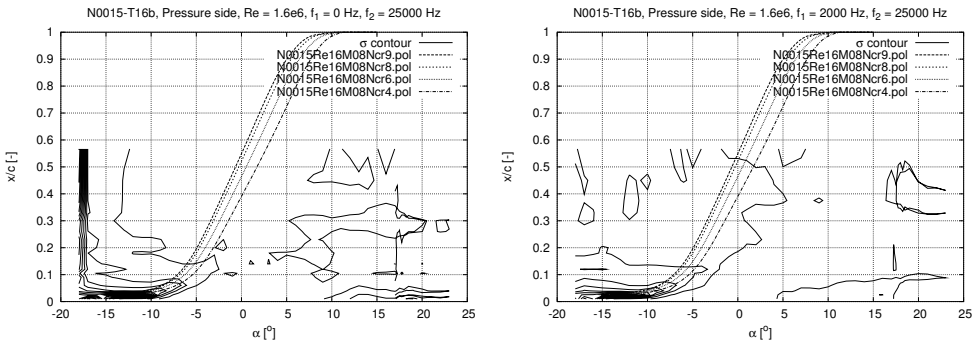

Figure 333: Contours of σ and XFoil data

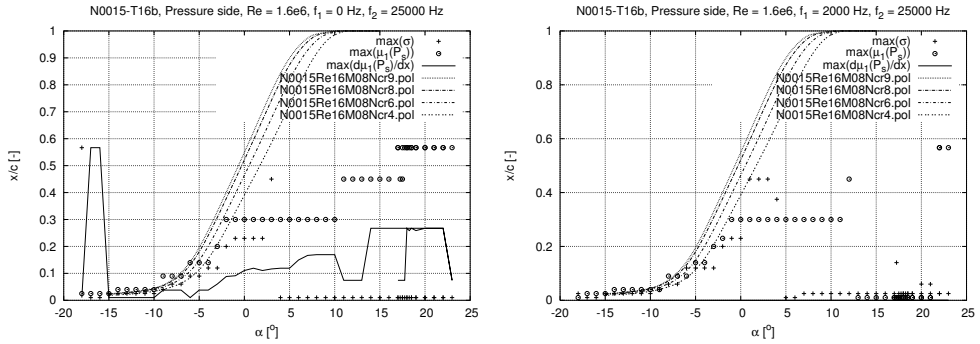

Figure 334: Transition detection

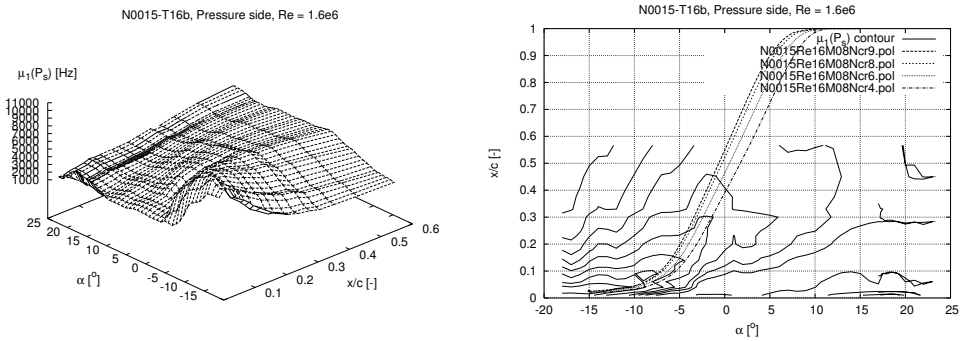

Figure 335: Fourier transform mean, $\mu_1(P_s)$

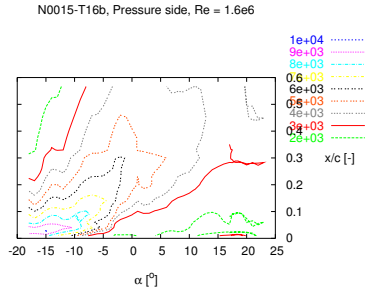

Figure 336: Contours of $\mu_1(P_s)$

```
N0015-T16b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
 17.00  0.0743       8348.0    3394.8
 17.25  0.0743       8856.9    3571.9
 17.50  0.0743       8449.2    3583.2
 17.75  0.0743       8242.6    3643.4
 18.00  0.2674       8762.3    3677.3
 18.25  0.2590       8871.6    3716.6
 18.50  0.2674       9343.0    3729.4
 19.00  0.2674       9160.7    3827.8
 20.00  0.2674       9727.4    4100.7
 21.00  0.2674       9931.1    4104.9
 22.00  0.2674       9107.7    4273.6
 23.00  0.0743       9150.2    4362.1
 22.00  0.2674       9622.3    4301.3
 21.00  0.2674       9433.5    4243.3
 20.00  0.2674      10355.4    4046.2
 19.00  0.2590       9087.5    3859.5
 18.50  0.2674       9094.7    3801.8
 18.00  0.2674       8416.6    3677.6
 17.50  0.2674       8898.7    3642.6
```

17.00	0.2674	8381.2	3618.3
16.00	0.2674	9452.3	3655.8
15.00	0.2674	9866.5	3669.1
14.00	0.2674	10749.6	3769.6
13.00	0.0743	10662.3	3983.6
12.00	0.0743	11205.5	4187.7
11.00	0.0743	11513.9	4330.2
10.00	0.1694	14237.7	4468.5
9.00	0.1694	13405.9	4500.7
8.00	0.1694	15265.6	4581.0
7.00	0.1666	18388.1	4730.2
6.00	0.1499	18724.4	4986.6
5.00	0.1191	22229.4	5103.9
4.00	0.1191	22604.9	5214.1
3.00	0.1163	27467.8	5303.1
2.00	0.1107	28452.1	5408.9
1.00	0.1191	24019.5	5422.0
0.00	0.1107	29654.4	5735.1
-1.00	0.0911	33710.1	5968.2
-2.00	0.0883	37506.4	6081.1
-3.00	0.0604	46635.5	6562.9
-4.00	0.0380	51777.3	6892.5
-5.00	0.0380	59957.4	7103.0
-6.00	0.0100	70327.9	7285.0
-7.00	0.0380	69657.9	7832.9
-8.00	0.0380	70193.0	8227.2
-9.00	0.0380	64592.9	8197.8
-10.00	0.0100	46707.4	8858.0
-11.00	0.0100	43596.2	9159.8
-12.00	0.0100	39237.4	9379.6
-13.00	0.0100	37744.5	9837.2
-14.00	0.0100	24543.2	9978.2
-15.00	0.0100	8016.6	10055.7
-16.00	0.5667	1676.2	9601.9
-17.00	0.5667	1598.3	9344.6
-18.00	0.0100	3177.1	9366.3

5.28 T3b Trip wire. Bump tape 2% 100x100

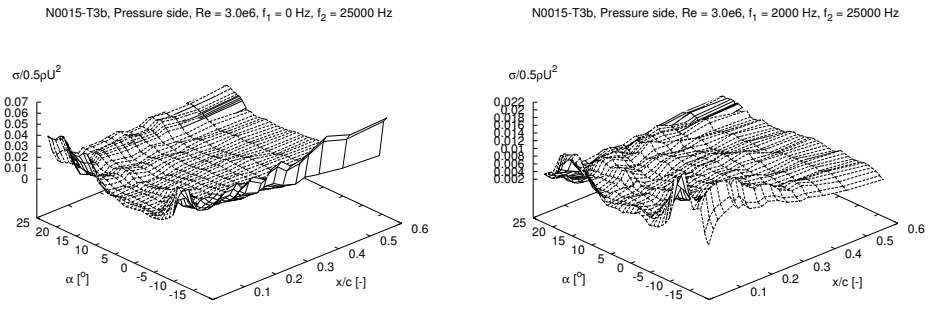

Figure 337: Pressure standard deviations, σ

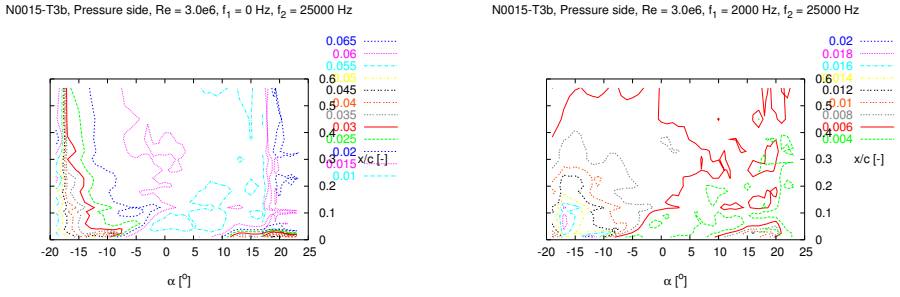

Figure 338: Contours of σ

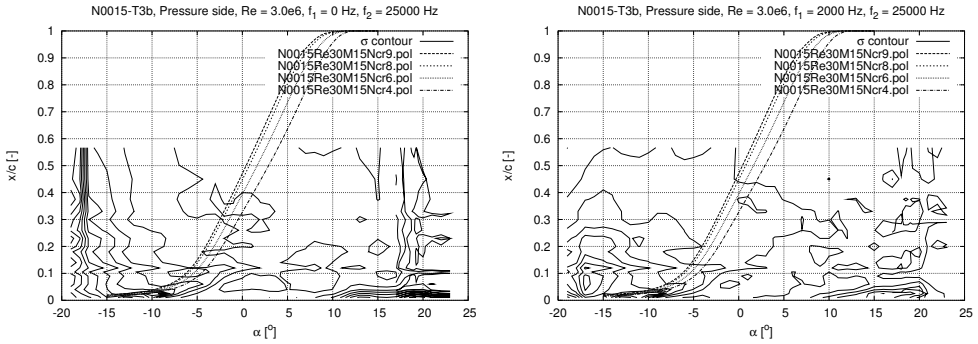

Figure 339: Contours of σ and XFoil data

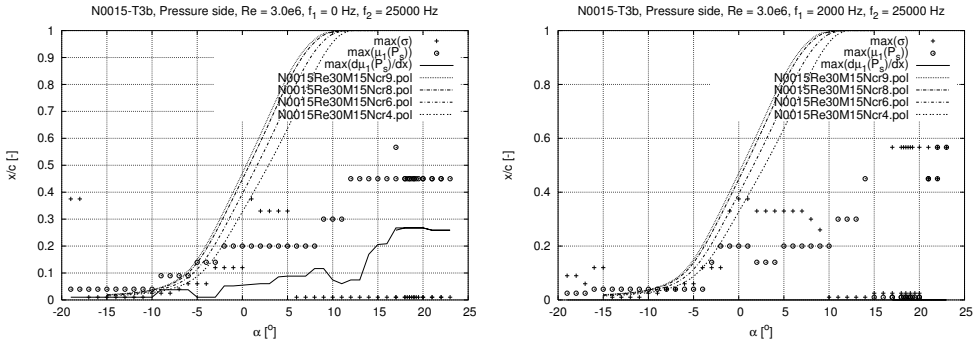

Figure 340: Transition detection

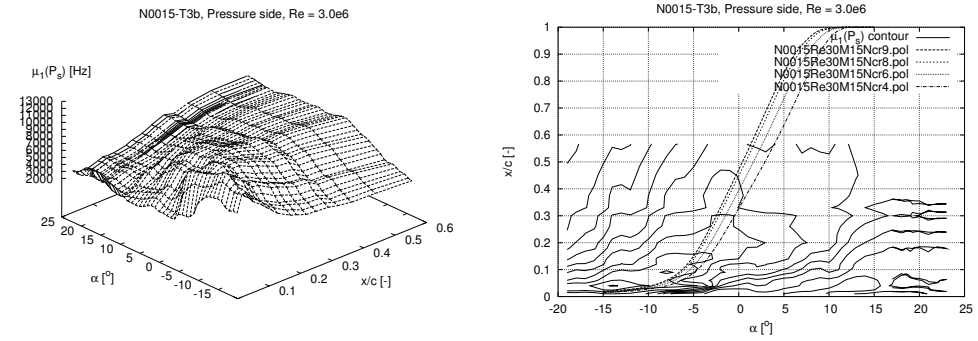

Figure 341: Fourier transform mean, $\mu_1(P_s)$

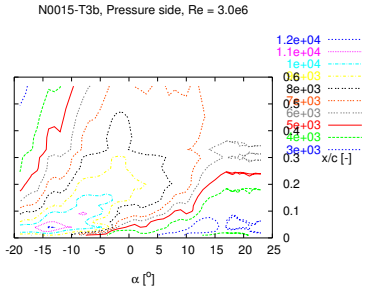

Figure 342: Contours of $\mu_1(P_s)$

```
N0015-T3b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions
```

alpha	xtr*	d(mu1)/dx*	max(mu1)
17.00	0.2590	18287.2	6488.7
18.00	0.2674	16882.2	6491.1
18.25	0.2674	16955.1	6546.1
18.50	0.2674	18013.4	6569.4
18.75	0.2674	17844.6	6584.3
19.00	0.2674	17770.2	6609.6
19.25	0.2674	18604.7	6756.2
20.00	0.2674	18863.8	6785.2
21.00	0.2590	20073.5	6853.6
22.00	0.2590	20163.3	6874.2
23.00	0.2590	19772.0	6925.9
22.00	0.2590	20592.6	6923.9
21.00	0.2590	18802.1	6859.6
20.00	0.2674	17459.8	6757.8
19.50	0.2674	17719.4	6719.5
19.00	0.2674	16626.0	6647.6
18.50	0.2674	16437.4	6569.0
18.00	0.2674	16695.2	6548.3
17.00	0.2674	17485.0	6402.1
16.00	0.2086	16648.3	6448.5
15.00	0.2058	17934.7	6646.5
14.00	0.1694	19001.7	6833.5
13.00	0.0743	22646.5	7047.9
12.00	0.0743	28682.7	7285.5
11.00	0.0604	36003.6	7543.3
10.00	0.0743	36825.1	7700.0
9.00	0.1163	35738.9	7792.9
8.00	0.1163	35916.1	7940.1
7.00	0.0883	40741.9	8071.4
6.00	0.0883	45640.3	8324.4
5.00	0.0883	49387.9	8643.8
4.00	0.0855	48926.2	8880.6
3.00	0.0604	49669.3	8990.4
2.00	0.0604	51858.7	9116.1
1.00	0.0576	55510.2	9204.3
0.00	0.0548	61967.1	9450.7
-1.00	0.0520	67068.9	9730.0
-2.00	0.0520	70850.5	9913.4
-3.00	0.0100	99747.6	10078.1
-4.00	0.0100	89471.3	10332.7
-5.00	0.0100	83100.2	10295.2
-6.00	0.0380	82164.7	10593.0
-7.00	0.0380	89670.1	10937.6
-8.00	0.0380	87557.1	11126.9
-9.00	0.0380	59143.4	10924.4
-10.00	0.0100	50123.4	11015.8
-11.00	0.0100	43228.4	11109.2
-12.00	0.0100	42564.8	11529.1
-13.00	0.0100	43141.6	11931.0
-14.00	0.0100	39579.5	12118.9
-15.00	0.0100	34145.2	11740.4
-16.00	0.0100	31778.7	11188.7
-17.00	0.0100	27791.9	10768.3
-18.00	0.0100	24708.1	10848.4
-19.00	0.0100	20901.7	10707.1

5.29 T6b Trip wire. Bump tape 2% 100x100

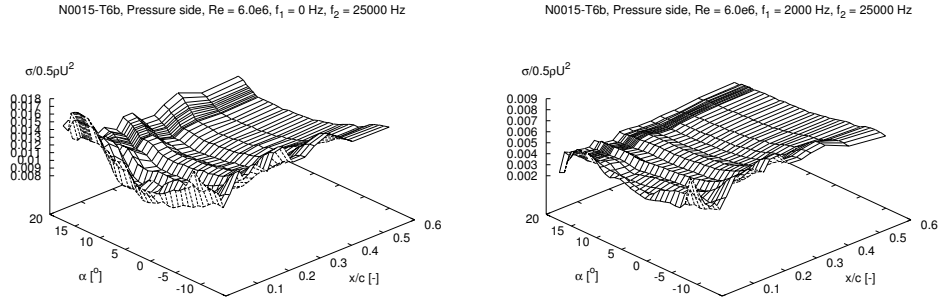

Figure 343: Pressure standard deviations, σ

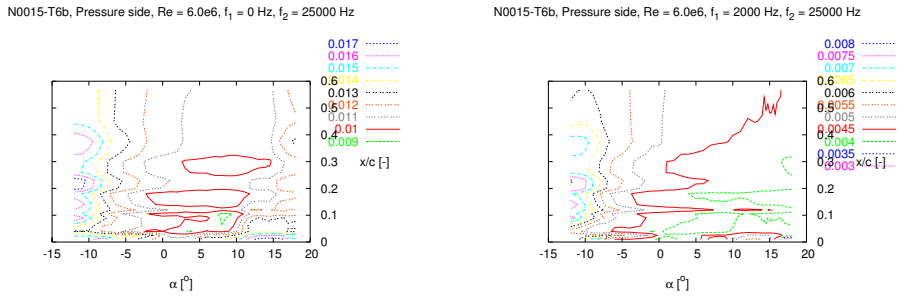

Figure 344: Contours of σ

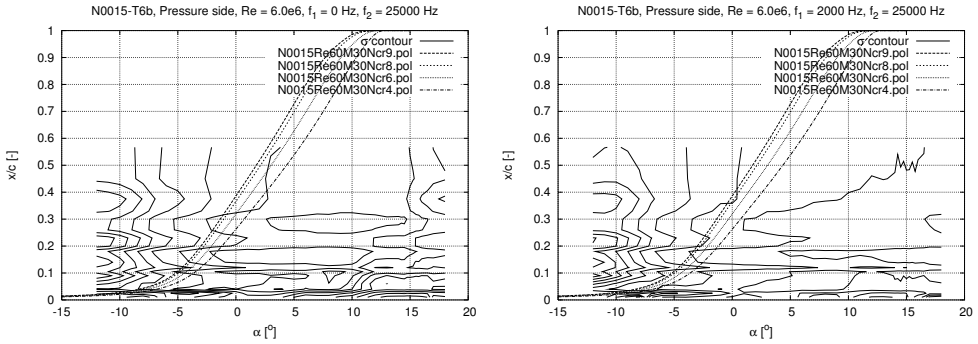

Figure 345: Contours of σ and XFoil data

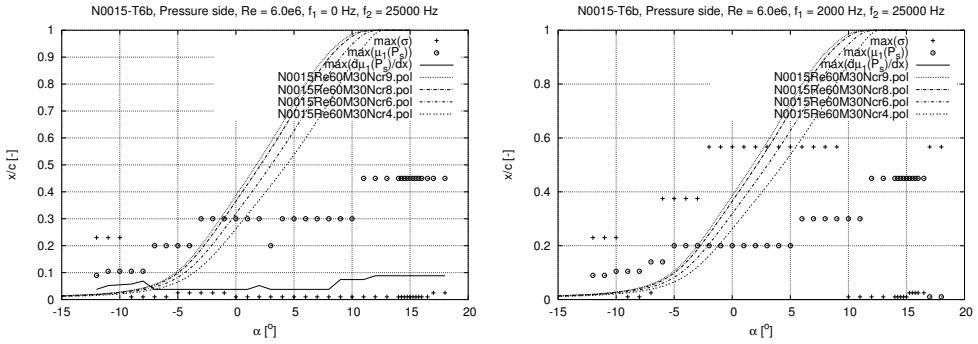

Figure 346: Transition detection

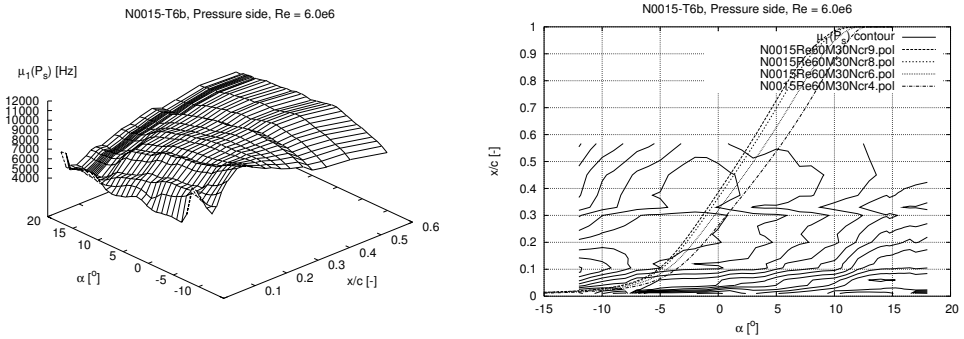

Figure 347: Fourier transform mean, $\mu_1(P_s)$

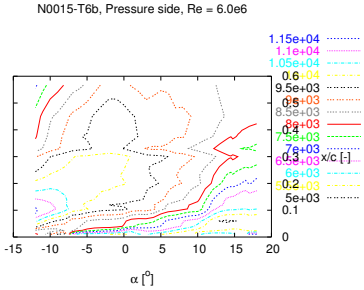

Figure 348: Contours of $\mu_1(P_s)$

```
N0015-T6b
alpha          [degrees] angle of attack
xtr*           [-]       transition point (x*=x/c) predicted by max[d(mu1(Ps))/dx*]
d(mu1)/dx*     [Hz/-]    d(mu1(Ps))/dx* evaluated at xtr* (=max[d(mu1(Ps))/dx*])
max(mu1)       [Hz]      max mu1 of all chordwise positions

alpha   xtr*    d(mu1)/dx*  max(mu1)
------  ------  ----------  --------
-12.00  0.0380     51667.5   11546.0
-11.00  0.0520     47125.3   11363.0
-10.00  0.0548     41498.5   11167.5
 -9.00  0.0576     34771.7   10945.5
 -8.00  0.0687     29726.1   10671.8
 -7.00  0.0380     41137.0   10356.6
 -6.00  0.0380     58120.5   10343.5
 -5.00  0.0380     53888.6   10228.3
 -4.00  0.0380     50956.3   10219.1
 -3.00  0.0380     50811.8   10203.4
 -2.00  0.0380     52412.8   10260.5
 -1.00  0.0380     53264.5   10207.0
  0.00  0.0380     50538.4   10112.1
  1.00  0.0380     41821.4    9970.0
  2.00  0.0520     35233.0    9818.4
  3.00  0.0380     33233.4    9662.7
  4.00  0.0380     34619.4    9611.5
  5.00  0.0380     32768.6    9581.1
  6.00  0.0380     30989.6    9491.1
  7.00  0.0380     31258.6    9278.6
  8.00  0.0380     28812.8    9235.8
  9.00  0.0743     29181.7    9083.3
 10.00  0.0743     31584.7    8923.9
 11.00  0.0743     30031.4    8820.3
 12.00  0.0883     27120.3    8784.3
 13.00  0.0883     26593.0    8589.7
 14.00  0.0883     24393.0    8444.7
 14.25  0.0883     23203.2    8382.1
 14.50  0.0883     22657.5    8359.9
 14.75  0.0883     22708.6    8453.6
 15.00  0.0883     22232.6    8455.6
 15.25  0.0883     21471.0    8426.4
 15.50  0.0883     21022.5    8396.1
 15.75  0.0883     20171.5    8366.0
 16.00  0.0883     20059.4    8315.6
 16.50  0.0883     19670.1    8303.2
 17.00  0.0883     19726.8    8225.8
 18.00  0.0883     18277.2    8182.1
```

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[1] Døssing M. High Frequency Microphone Measurements for Transition Detection on Airfoils. Risø R-report ISBN 978-87-550-3674-1, Risø DTU, Wind Energy Department, 2008.

[2] Døssing M. High Frequency Microphone Measurements for Transition Detection on Airfoils - Risø B1-18 Appendix Report. Risø R-report ISBN 978-87-550-3675-8, Risø DTU, Wind Energy Department, 2008.

[3] Døssing M. High Frequency Microphone Measurements for Transition Detection on Airfoils - Risø C2-18 Appendix Report. Risø R-report ISBN 978-87-550-3676-5, Risø DTU, Wind Energy Department, 2008.

[4] Drela M. XFOIL: An Analysis and Design System for Low Reynolds Number Airfoils. lecture Notes in Engineering: Low Reynolds Number Aerodynamics, T.J. mueller (ed.), Springer Verlag, New York, **54**. 1989.

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Risø's research is aimed at solving concrete problems in the society.

Research targets are set through continuous dialogue with business, the political system and researchers.

The effects of our research are sustainable energy supply and new technology for the health sector.